Although the words "he," "him," and "his" are used sparingly in this manual to enhance communication, they are not intended to be gender driven nor to affront or discriminate against anyone reading *Boatswain's Mate 1 & C*, NAVEDTRA 10122-E.

Naval Education And Training Program Development Center

BOATSWAIN'S MATE 1 & C

NAVEDTRA 10122-E

DEPARTMENT OF THE NAVY ★ CHIEF OF NAVAL EDUC AND TNG ★

1982 Edition Prepared by
BMCS Neil F. Padgham

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PREFACE

This rate training manual and nonresident career course (RTM/NRCC) form a self-study package that will enable Boatswains's Mates to help themselves fulfill the requirements of their rating.

Designed for individual study and not formal classroom instruction, the RTM provides subject matter that relates directly to the occupational standards of the Boatswain's Mate rating. The NRCC provides the usual way of satisfying the requirements of completing the RTM. The set of assignments in the NRCC includes learning objectives and supporting items designed to lead students through the RTM.

This training manual and nonresident career course were prepared by the Naval Education and Training Program Development Center, Pensacola, Florida, for the Chief of Naval Education and Training. Technical assistance was provided by the Fleet Training Command, Norfolk, Virginia; Amphibious Schools Command, Little Creek, Virginia; Fleet Training Group, Guantanamo Bay, Cuba; United States Naval Academy, Annapolis, Maryland; Naval Sea Systems Command, Washington, D.C.; Naval Safety Center, Norfolk, Virginia; and the U.S. Navy Cargo Handling and Port Group, Cheatham Annex, Williamsburg, Virginia.

1982 Edition

Stock Ordering No.
0502-LP-050-6120

Published by
NAVAL EDUCATION AND TRAINING PROGRAM
DEVELOPMENT CENTER

UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON, D.C.: 1982

THE UNITED STATES NAVY

GUARDIAN OF OUR COUNTRY

The United States Navy is responsible for maintaining control of the sea and is a ready force on watch at home and overseas, capable of strong action to preserve the peace or of instant offensive action to win in war.

It is upon the maintenance of this control that our country's glorious future depends; the United States Navy exists to make it so.

WE SERVE WITH HONOR

Tradition, valor, and victory are the Navy's heritage from the past. To these may be added dedication, discipline, and vigilance as the watchwords of the present and the future.

At home or on distant stations we serve with pride, confident in the respect of our country, our shipmates, and our families.

Our responsibilities sober us; our adversities strengthen us.

Service to God and Country is our special privilege. We serve with honor.

THE FUTURE OF THE NAVY

The Navy will always employ new weapons, new techniques, and greater power to protect and defend the United States on the sea, under the sea, and in the air.

Now and in the future, control of the sea gives the United States her greatest advantage for the maintenance of peace and for victory in war.

Mobility, surprise, dispersal, and offensive power are the keynotes of the new Navy. The roots of the Navy lie in a strong belief in the future, in continued dedication to our tasks, and in reflection on our heritage from the past.

Never have our opportunities and our responsibilities been greater.

CONTENTS

CHAPTER 1

BOATSWAIN'S MATE BILLETS AND DUTIES

As a Boatswain's Mate, you may be assigned to any of the numerous vessels of the U.S. Fleet. Aboard each of these ships your job is apt to be a bit different from the job you just left; however, the duties are basically the same. As a trained Boatswain's Mate, you can go aboard any ship and, after a short period of indoctrination, perform assigned duties as well as any Boatswain's Mate aboard.

THE DIVISION PETTY OFFICER

Usually, when reporting aboard, a Boatswain's Mate is assigned to a division and assumes the duties of division petty officer. As a Boatswain's Mate First Class, you may be the leading petty officer of the division and, as such, be responsible for its operation. You are, of course, subordinate to the division officer; however, a division officer today has so many collateral duties one person must be depended upon to assume some of the load. That person is you, the leading petty officer. Therefore, you must be able to organize the division so all assignments will be completed promptly and efficiently. To do this, you must be fully aware of what is to be accomplished and the problems likely to be encountered.

As a Chief Boatswain's Mate, you will be an assistant to the ship's boatswain and the first lieutenant. You may have to muster with one of the deck divisions, but you probably will not have the responsibilities of a single division. Instead, you will be concerned with the overall operation of the deck department. Your value as a BMC will be judged by your ability to coordinate the work of several divisions. You are no longer a division petty officer, any more than the head of a department is a division officer; thus, the running of the divisions must be left to the division officers and petty officers.

WORK ORGANIZATION

You already know from past experience that advance information on an operation enables you to make appropriate preparations, thereby ensuring the operation will take place with a minimum of confusion. Advance planning is essential to running a division. For example, consider your ship's weekly schedule and begin to make plans for the next week's work. If you find that the ship is going to be moored the following week, you can plan on getting some much-needed abovedeck painting done—something you could not accomplish if the ship were underway.

Another aid in planning your work is the plan of the day. The plan of the day is more detailed than the ship's weekly schedule and tells when certain events are to occur. Read the plan of the day in the evening when you are making preparations for the next day's work. It will tell you if there are changes to the weekly schedule and, if necessary, you can alter your plans accordingly. For example, you would not want your crew to start painting the gangway at 1300 if you knew the admiral were coming aboard for a conference at 1330.

You should consult frequently with your division officer if you are to plan for the future. The division officer gets the word from the department head, knows of projected plans which have not been made known to the crew, and may notice items requiring correction that have escaped your attention. Though you may be running the division, the responsibility for its

operation still belongs to the division officer. You will find that, if kept informed of the work in progress and your plans for meeting future problems, the division officer may be more than happy to let you run the division.

Work Assignments

To run the division efficiently, your crew must be organized so they will know exactly who will be responsible for each job when you begin making your long-range plans.

For example, it is a simple matter to assign division personnel to cleaning stations. Consequently, they know where to go and what to do each morning at turn to. Some divisions, however, do not make such assignments. When a job is to be done, the petty officers try to find enough personnel to perform the necessary work. Since there has been no coordination in the work assignments, one petty officer might pull a crewmember from one station for reassignment to another job. In the resulting confusion, very little work gets done and what is done is frequently wrong. Eventually, the leading petty officer of this division is called on the carpet and told to straighten things out.

It is important to have your division so organized that it can accomplish the day's routine in an orderly and efficient manner. Certain personnel should be assigned to boat falls, for example. When the word is passed that a boat is to be lowered or picked up, these crewmembers will assemble at the appropriate section of the ship prepared to lower or haul away as directed. A similar evolution takes place when the winch is to be used. Only one person is responsible for the winch; the others are assigned other duties. After a period of time you will probably shift personnel from one job to another so that they may become proficient in all areas of seamanship.

As you have undoubtedly observed, there are a few individuals who excel in any job given them. They have a certain enthusiasm which they carry into any assignment; they are happy when they are working. These individuals are your future leaders. It is your duty to see that they get a fair break. All too often when a crewmember does an excellent job of sidecleaning, for example, the chief sidecleaner will request the crewmember be kept on that duty for another quarter. You are not only hurting the crewmember, but you are hurting the Navy if you permit that. The same holds true for messcooking. Many people in the Navy look upon this duty as a sort of punishment; consequently, most of them do not like to do it. When the messdeck MAA gets a person who likes the job or, though not liking it, still does the work without complaint, the MAA usually requests the crewmember be kept at this job another quarter. These assignments, however, are for one quarter only and it is your job to see to it that good personnel do not waste their time messcooking or side-cleaning after their normal tour of duty is completed. They are of no use to you on deck when they are performing other duties, and you cannot supervise their training while they are messcooking or sidecleaning.

One other item is worth bringing out at this point—the area of the ship assigned your division. The ship's organization book, based on the *Standard Organization and Regulations of the U.S. Navy*, OPNAVINST 3120.32 (this manual is described more fully in *Military Requirements for Petty Officer 1 & C*, NAVEDTRA 10057 series), tells you to the inch the boundaries for which each division is responsible, thus eliminating any potential disagreement on the subject between division leading petty officers. It also contains all the requirements of the division; the guns and other stations it mans; the boats it handles, if any; the number of messcooks and sidecleaners it provides; the equipment it must send to general drills, etc.

Differences of opinion occasionally arise between petty officers in charge of adjoining areas, but there is no point arguing about facts. Such differences can always be decided finally and quickly by referring to the organization book.

The *Military Requirements for Petty Officer 1 & C* RTM also covers several of the requirements for Boatswain's Mate. For example, it discusses maintenance of the watch, quarter, and station bill, survey and requisition of equipment, and stowing and accounting for repair parts. In addition, it gives a fairly comprehensive coverage of the various aspects of training.

MISCELLANEOUS RESPONSIBILITIES

The miscellaneous responsibilities of a deck division leading petty officer are innumerable. Many times a day you will be called upon to solve a new type of problem. For some of these problems there are no hard-and-fast rules—you will have to use your ingenuity. All in all, you will discover that most of your other responsibilities could be put under the headings of discipline, liberty and leave, and records and logs.

DISCIPLINE

Let us consider discipline first. Unless you have exceptional personnel under you, that will be one of your biggest problems as leading petty officer of a large deck division. If you are honest and fair with all hands, you undoubtedly will keep the difficulty to a minimum. On the other hand, if you give special consideration to your liberty buddies, you are going to be causing problems, not solving them. Set down necessary rules for the division and stick to them. The easiest and most efficient way to supervise your division is to delegate authority to petty officers under you. That applies to discipline as well as to work. Always be ready with advice and help if your POs ask for it, but insist they assume their responsibilities and exercise their authority to best advantage. Do not harp on every small detail; leave minor infractions to your second and third class petty officers. Make certain they take action to stop petty annoyances immediately. However, more serious violations, such as insubordination, should be brought to an immediate halt. If personnel know you will not tolerate infractions of division regulations, you will have little trouble. Treat all personnel the same. Do not place one person you dislike on report for a violation if you would not do the same if a friend were involved.

One other matter is worth mentioning at this point. Do not cover up for your personnel. The temptation to do so at times is great. More than one leading petty officer has learned to regret that by being a "good guy," the efficiency of the division was ruined. If you cover up for one person, each person in the division should be accorded the same consideration. It is difficult, however, to run a division when the leading petty officer is covering up for personnel who miss muster. Perhaps one morning the whole division will decide to sleep in. Where would you be then? Do not feel you have to give anyone a break. If you do it for one, you must do it for all. If you run a taut division, your crew will respect you and cooperate.

LIBERTY AND LEAVE

A subject closely related to discipline is liberty and leave. The deprivation of leave or liberty is reserved for the commanding officer or a court-martial. Do not take it upon yourself to restrict personnel in your division; you do not have the authority.

On the other hand, you do have numerous duties to perform in connection with liberty and leave. Your recommendation is required on requests for leave and special liberty, so you can see you have wide and far-reaching responsibilities in this area. Here again, the manner in which you perform your duties will tell to a large extent the type of division you will have. If you coordinate liberty and leave fairly and justly, you should have a good division; if you give special favors to a chosen few, you are creating an unhealthy situation.

While you do not have the authority to discipline, and granting leave and liberty is not within your province, your signature must appear on special requests. The decision to grant or turn down requests based on your recommendation will be easier for the division officer if your judgment is valued. The department head and executive officer, noting identical recommendations, probably will follow suit; thus, your favorable recommendation becomes a thing to be sought. You can give it to deserving personnel as a small, visible reward, and withhold it from those who consistently fail in their duties.

RECORDS AND LOGS

As a Boatswain's Mate First Class or Chief, you will find that there are a surprising number of records you are required to maintain. The muster roll is an example. While all BMs are familiar with this important record, probably, few ever think of it as recordkeeping. But

consider it a moment. The muster roll must be kept up to date to reflect the latest personnel changes in the division. When personnel are transferred or received, you must make appropriate changes, trying at all times to keep the sections evenly balanced. You must consult it when you make up the watch bill and other personnel assignment lists. Keeping track of personnel in the deck division of a large ship requires a lot of bookkeeping. It is an important job and one that can lead to considerable embarrassment on your part if it is not done properly.

Bunk and Locker Assignments

You will also be responsible for bunk and locker assignments. Your division is allotted certain bunks and lockers for its personnel. It is up to you to ensure that each person who comes into your division is assigned a bunk and locker. When an individual is transferred from the division, remove the name from your muster list so the bunk and locker will be available for a new person coming into the division. A correct bunk assignment list is especially important when you consider that an oncoming night watch must be awakened. If you have listed an incorrect bunk number on the watch list, it means that the wrong person will be awakened.

Inspection Checkoff List

Another record you will maintain is the inspection checkoff list. It lists the gear for which your division is responsible. It will be your job to determine if such gear is functioning correctly and is properly maintained. At regular intervals you will make the rounds and check boats assigned your division to see that they have all equipage required; inflatable lifeboats must also be checked for discrepancies. Booms, davits, winches—everything on the inspection checkoff list—must be inspected periodically and such inspection noted on the list. Naturally, defects must be rectified.

Anchor Log

An anchor log is a permanent record of your ground tackle and its use. It includes serial numbers, weights, and types of all anchors; serial numbers of the shots of chain and their location in the cable; the length of each cable in fathoms; and serial numbers of each detachable link, both those in use and spares. When an anchor is dropped, the time and date are noted along with the depth of water, scope of chain, type of bottom, location of the ship at the time of drop, and any pertinent remarks, such as unnatural strains on the cable. When the anchor is weighed, that fact also is noted.

Another section of the log is used to record maintenance of the ground tackle and the repositioning of shots within the cable.

Custody Records

Every BM must recognize that custody records are necessary to keep account of the tremendous amount of equipage assigned, some of which may be controlled equipage. The supply department requires a signature from the head of the department for controlled equipage items that are subject to pilfering. The department head, in turn, may insist that recipients of the gear sign memorandum receipts. Usually, a memorandum receipt is a mimeographed form on which can be entered the name and grade or rate of the person taking custody.

Even if receipts are not required, it is a good idea to keep records of gear issued to personnel. Some POs have their personnel initial these entries. Such records permit better control and expedite inventories.

More information on the subject of supply can be found in the military requirements for petty officers series of textbooks.

Ship Equipment Configuration Accounting System (SECAS)

The ship equipment configuration accounting system (SECAS) is a program which identifies shipboard equipment/components, precisely locates the identified items, records all associated data, verifies accomplishment of specific engineering changes, and provides these data to engineering, supply support, and operational managers.

SECAS serves as a single multipurpose configuration status accounting system for the Navy. Its immediate impact is on some of the older equipment accounting systems. As the Navy has evolved and become modernized, the configuration of equipment and systems in the

fleet has become more complex. As Navy managers and planners have turned to more sophisticated management systems and techniques, their information needs have become more exacting. To meet these needs and keep track of equipment configuration, new information systems have been created. SECAS improves the quality of hardware reporting, provides information needed by other naval management systems, reduces the paper workload of ships' personnel, and assists programs that furnish spares, documentation, and training.

THE BOATSWAIN'S MATE ASHORE

Since Boatswain's Mate is primarily a seagoing rating, there are not too many billets ashore tailored to a Boatswain's Mate's qualifications. Therefore, when a Boatswain's Mate becomes eligible for shore duty, the duty assigned is somewhat different from that for which the Boatswain's Mate was trained.

GENERAL SHORE DUTY

Quite often the BM is sent ashore in a general shore duty billet. These duties include base security, shore patrol, BEQ manager, boat pools, and other assignments depending on the requirements of the command.

INSTRUCTOR DUTY

Boatswain's Mates frequently are given duty as instructors. In this capacity you may be a recruit company commander or you could be assigned to a Naval Reserve Center, responsible for the training of reservists. Fleet schools such as Leadership and Management and Education Training (LMET), Amphibious School, and Firefighting School use a number of Boatswain's Mates as instructors.

There also are other billets, such as recruiting duty and MAAG mission to which Boatswain's Mates may be assigned while ashore, but the foregoing are the most common.

CHAPTER 2

RIGGING

The art of rigging may seem considerably less important in this age of complex weight handling machinery than it was in the era of sailing ships. Nevertheless, when using machinery, an uninformed person runs the risk of making mistakes that might result in ruining expensive equipment or seriously injuring personnel. Then, too, there are times when such machinery is not available and personnel must depend on their own efforts. In such circumstances, the one who can get a job done safely and with the least amount of effort is the accomplished rigger.

As you know, the safe working load of most weight handling equipment aboard ship is clearly marked some place on the equipment (heels of booms, nameplates on motors, and so on), but when you jury rig, you will have to compute the forces you have to contend with and select gear that will carry the load.

Solving rigging problems frequently requires ingenuity, but if the rigger knows the principles of physics on which rigging is based, the solutions to the problems are more readily apparent.

In this chapter we will try to present, in as simple a form as possible, some of those principles.

FORCES IN A SPAN

A force has both magnitude and direction and can be illustrated by a vector; that is, a line of certain length drawn in the direction in which the force acts. The length of the line represents the magnitude of the force.

Because our primary interest is in the tensions and compressions set up in the various parts of weight handling equipment, we shall illustrate how to find the value of these tensions and compressions by means of vectors in force triangles and parallelograms.

The figures we use in this chapter can be drawn in various ways, depending on the drawing instruments available. All of them, however, can be constructed with only a rule and a protractor. In an emergency, half a compass rose from a navigation chart will serve for the latter item.

View A in figure 2-1 represents a 2-ton weight suspended by the cargo whips in the yard-and-stay rig. The whips form an angle of 45°. In our example, the weight hangs midway between the boom heads; thus, the whips share the load equally.

To find the tension in the whips, we can construct either a force triangle or a force parallelogram. We have chosen the latter, because it is more representative of the situation we wish to illustrate and, therefore, is easier to understand.

The accepted method of constructing a force parallelogram is shown in view B of figure 2-1. A force vector is drawn from the point of action (A). The whips are extended down and, from the end of the vector (B), lines are drawn parallel to each of the cargo whips. This completes the parallelogram, AyBx.

The same result can be obtained with less chance for construction errors by drawing the force vector between the whips, as in view C. We will use that method.

Any convenient length can represent the weight. In this case we have selected 2 inches to show magnitude, and because the force is gravity, we have drawn the vector vertically. The arrow points in the direction in which the force acts. Because the weight is midway between the

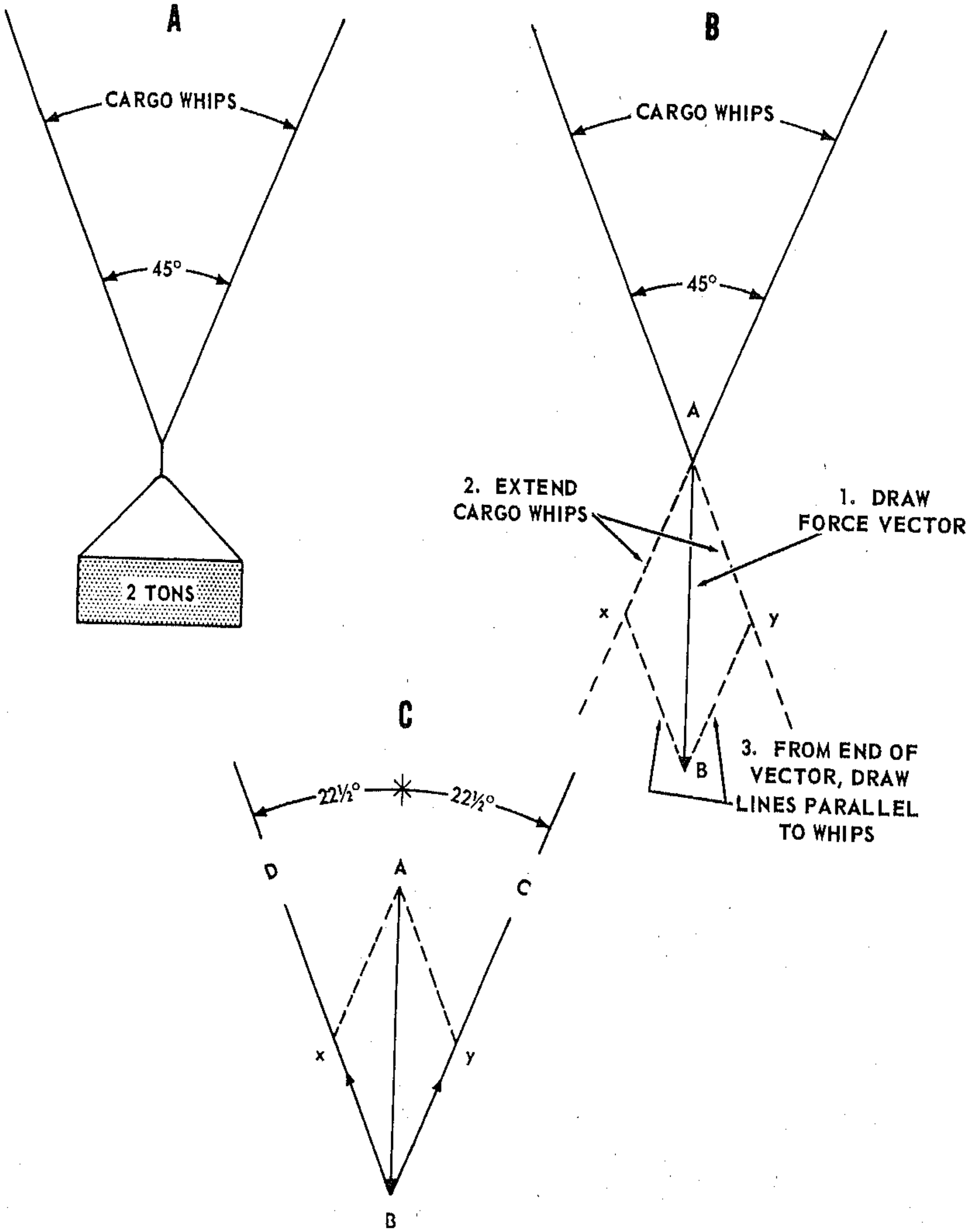


Figure 2-1.—Finding tension in cargo whips with load suspended midway between boom heads. 58.1

boom heads, the angles between the weight vector and the whips are equal, and since the forces counteracting the weight must be in a generally opposite direction from those representing the weight, the arrows on the whips point upward. You will learn of the significance of these arrows later in this chapter.

Our next step is to draw from point A, lines Ax and Ay, respectively, parallel to whips BC and BD. If the parallelogram is drawn correctly, Ax equals Ay, and Ay equals 1-1/16 inches. Since 1-1/16 inches is slightly more than half of 2 inches, it is obvious the tension in each whip is slightly more than half of the load or slightly more than 1 ton.

Usually this answer would suffice, but sometimes it is necessary to be more explicit. In many cases, you can divide the vector into units equal to the fraction with which you are concerned. Thus, in our example, we divide our 2-inch vector into units 1/16-inch long; then, each of the 32 units represents 125 pounds, as shown below.

2 tons = 4000 lbs

$$\begin{array}{r} 125 \\ 32\overline{)4000} \\ \underline{32} \\ 80 \\ \underline{64} \\ 160 \\ 160 \end{array}$$

Therefore, the 1-1/16 inches or 17 units with which we are concerned is equal to:

$$\begin{array}{r} 125 \\ \underline{17} \\ 875 \\ \underline{125} \\ 2125 \end{array} \text{ lbs = tension in each whip}$$

A faster and simpler way to solve the arithmetical part of the problem is to use fractions.

First, find the relationship between the vector representing weight and that representing tension; that is, what fraction the tension vector is of the weight vector. Then multiply the load by that fraction.

1-1/16 ÷ 2

or

17/16 ÷ 2/1

(invert the divisor and multiply)

$$\frac{17}{16} \times \frac{1}{2} = \frac{17}{32}$$

(17/32 of the load equals tension in the whips)

$$\frac{17}{32} \times \frac{4000 \text{ lbs}}{1} = \frac{68000}{32} = 2125 \text{ lbs}$$

COMPONENTS OF FORCES

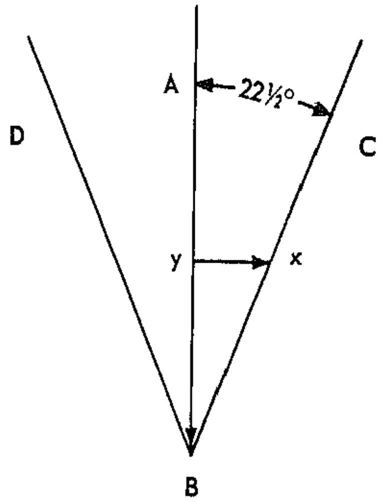
No doubt some readers may wonder why total tension in the two whips is greater than the load. This situation is easy to understand if one considers the fact that part of the force is exerted away from the load rather than directly upward.

The value of this sidewise (horizontal) force is not important to this problem, but knowing how to determine it might help you to understand some of the other problems in this chapter.

Upon casual inspection, one might expect the horizontal force to equal 125 pounds, but that is not the case.

The method of solving a problem of that type is to break the single diagonal force into its components; that is, vertical and horizontal forces.

Using the same quantities and scale as in the preceding problem, construct a diagram as shown in figure 2-2. Angle ABC equals 22-1/2°. Because 1-1/16 inches represented the tension in the whip in the other problem, and as we are using the same scale, mark off Bx as 1-1/16 inches. Now, from point x drop a line (xy) perpendicular to line AB. (That is normally spoken of as dropping a perpendicular from the point to the line. That is, from point x drop a perpendicular (xy) to line AB.)



58.2(58D)
Figure 2-2.—Determining vertical and horizontal components of a diagonal force.

Measure $\underline{xy}$ (horizontal force) and $\underline{By}$ (vertical force). The vector $\underline{xy}$ equals 13/32 inch and $\underline{By}$ equals 31/32 inch. Since we already know that 1/16 inch on our scale equals 125 pounds and because 13/32 could be considered as 6.5/16, $\underline{xy}$ equals:

$$\begin{array}{l} 125 \\ \underline{6.5} \\ 625 \\ \underline{750} \\ 812.5 \end{array}$$

812.5 or to round off, 813 pounds = force of horizontal component

Let us use fractions to work the other half of the problem. Remember, we are concerned with the relationship of the vertical component to the diagonal vector—not to the load vector.

Hence, $\frac{31}{32} \div \frac{17}{16} = \frac{31}{32} \div \frac{34}{32}$

$$\frac{31}{\cancel{32}} \times \frac{\cancel{32}}{34} = \frac{31}{34}$$

$$\frac{31}{34} \times \frac{2125 \text{ lbs}}{1} = \frac{65875}{34} = 1938 \text{ lbs}$$

= force of vertical component

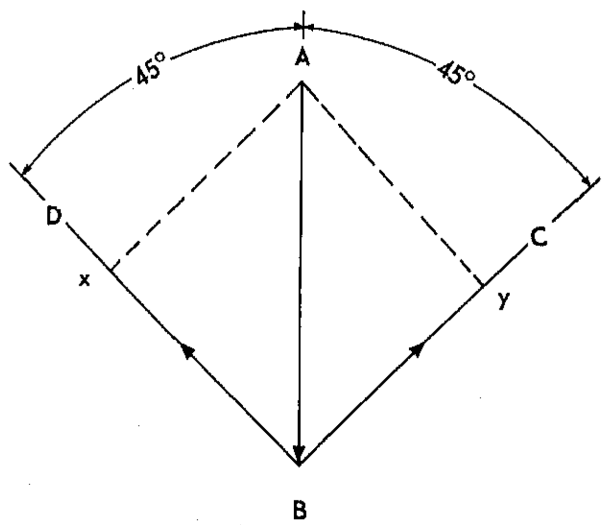
INCREASING THE ANGLE BETWEEN WHIPS

It is important to know what happens when the angle between cargo whips increases as the load is raised; therefore, let us hoist our load to where the angle formed by the whips is about 90°. We will use the same situation, weight, and scale as before; that is, a 2-inch vector represents a 2-ton load plumbed midway between the boom heads. See figure 2-3.

We complete our parallelogram as before with $\underline{Ax}$ parallel to $\overline{BC}$ and $\underline{Ay}$ parallel to $\overline{BD}$. Now when we measure either $\overline{Bx}$ or $\underline{By}$ we find that each is 1-7/16 or 23/16 inches long.

$$\begin{array}{ll} 125 & \text{lbs per unit} \\ \underline{23} & \text{units} \\ 375 & \\ \underline{250} & \\ 2875 & \text{lbs} \end{array}$$

Therefore, tension in each of the whips is 2875 pounds.



58.3
Figure 2-3.—Tension in cargo whips spread to a 90° angle.

You might say that a mere 750-pound increase in tension when the angle between whips is doubled is not too great, and that may be true. However, if you take the trouble to work a few more problems of that type with larger and larger angles between whips, you may be startled to find how rapidly the tension increases from that (90°) point on. For example, with an increase of 30° (that is, with the whip's forming an angle of 120°), the tension in each whip is exactly equal to the load.

Increase the angle another 20° to 140° and the tension is equal to almost 110% of the load. Another 10° increase in angle brings the tension to around 124% of the load. At 180°, the tension is infinite.

From the foregoing, it is not difficult to understand how important it is to refrain from hoisting a load higher than is necessary.

UNEQUAL TENSIONS

Naturally, as a load is racked, the tensions in the whips change; one increases and the other decreases. If the load is stopped when the whips are in the situation shown in figure 2-4, what is the tension in each whip?

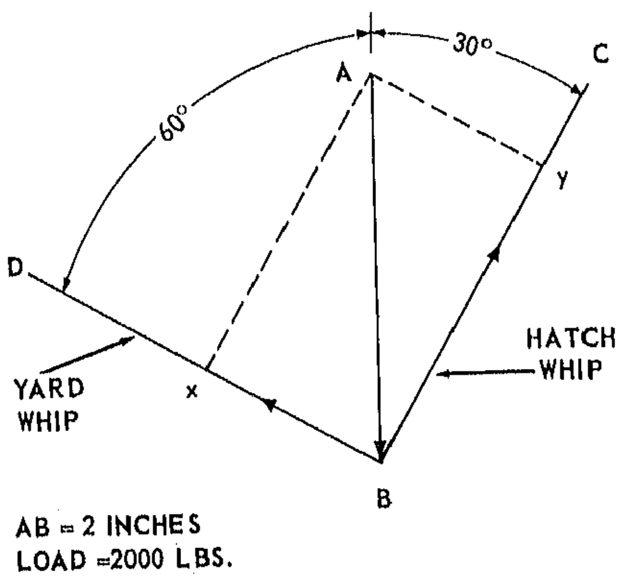


Figure 2-4.—Unequal tension in cargo whips.

Before reading further, construct your own parallelogram and, using fractions, work out the problem; then check your figures with those that follow.

$\underline{By}$ = 1-3/4 inches

$1\text{-}3/4 \div 2 = \frac{7}{4} \div \frac{2}{1}$

$\frac{7}{4} \times \frac{1}{2} = \frac{7}{8}$

$\frac{7}{8} \times \frac{2000}{1} = \frac{14000}{8} = 1750 \text{ lbs}$

Tension in the hatch whip equals 1750 pounds.

$\underline{Bx}$ = 1 inch

$1 \div 2 = 1/2$

$\frac{1}{\cancel{2}} \times \frac{\overset{1000}{\cancel{2000}}}{1} = 1000 \text{ lbs}$

Tension in the yard whip equals 1000 pounds.

OVERCOMING INERTIA

We must point out here that the foregoing situations and those that follow concern loads at rest. In such cases, for every force acting on a body there is an equal and opposing force or combination of forces. To set a body at rest into motion, an additional force is required. While for moderate loads this extra force is not great, it should be taken into consideration if, in an emergency, you contemplate hoisting any load that exceeds the safe working load.

The force required is directly proportional to the weight and the acceleration; hence, the slower the rate of acceleration, the less force required and, consequently, the less additional strain in the equipment. Therefore, accelerate slowly and reduce the chance of parting something.

BOOMS, TOPPING LIFTS, AND STAYS

Computing the forces acting on booms, topping lifts, and stays is no more difficult than

computing tension in cargo whips. However, in this case we use a force triangle rather than a parallelogram.

To construct the diagram needed, you must know four things:

1. Height of mast from boom gooseneck to point at which the topping lift is attached.
2. Length of boom.
3. Angle between boom and mast.
4. Angle between mast and stay.

All of this information can be taken from the ship's blueprints except item 3, which you will have to measure or estimate.

For our example we have selected the following values:

1. Height of mast, 25 feet.
2. Length of boom, 20 feet.
3. Angle between boom and mast, 45°.
4. Angle between mast and stay, 25°.

The diagram must be drawn to a suitable scale, and we have chosen 1 inch to equal 5 feet (1″:5′).

If we assume the weight to be 5 tons and select a 2-inch vector to represent that weight, our diagram will appear as in figure 2-5.

NOTE: Choosing a 2-inch vector here does not constitute a change in scale, because the two are distinct. The 1″:5′ scale concerns the lengths in the structure itself, while the 2-inch vector represents the force of the load.

The weight vector ($\underline{CW}$) is drawn vertically; hence, parallel to the mast. $\underline{Cx}$ is an extension of $\underline{AC}$, and $\underline{Wx}$ is drawn parallel to the boom ($\underline{CB}$). Thus, our force triangle is complete.

Points where parts of the rig join are called structure joints, and arrows on the force triangle are called directional force arrows. These arrows always point head to tail, or "chase" each other and, when transferred to the parts of the rig that the parts of the triangle represent, show whether the force in the part is tension or compression. An arrow pointing toward the structure joint concerned shows compression, and one pointing away shows tension.

We start with the arrow on the weight vector and it must point downward. The arrows on the legs of the force triangle that represent the boom ($\underline{Wx}$) and the topping lift ($\underline{Cx}$) respectively, point upward. When these arrows are transferred to the boom and the topping lift, we find by inspection that the arrow on the boom points toward the structure joint ($\underline{C}$), and the other away from it. Therefore, the boom is under compression and the topping lift under tension.

$\underline{Wx}$ measures 1-5/8 inches and, as you remember, we must establish the relationship of this length to the 2-inch load vector.

Therefore:

$$\frac{13}{8} \div \frac{2}{1}$$

$$\frac{13}{8} \times \frac{1}{2} = \frac{13}{16}$$

$$\frac{13}{16} \times \frac{5 \text{ tons}}{1} = \frac{65}{16} = 4\text{-}1/16 \text{ tons}$$

Compression in the boom equals 4-1/16 tons or 8125 pounds.

$\underline{Cx}$ measures 1-7/16 inches.

Therefore:

$$\frac{23}{16} \div \frac{2}{1}$$

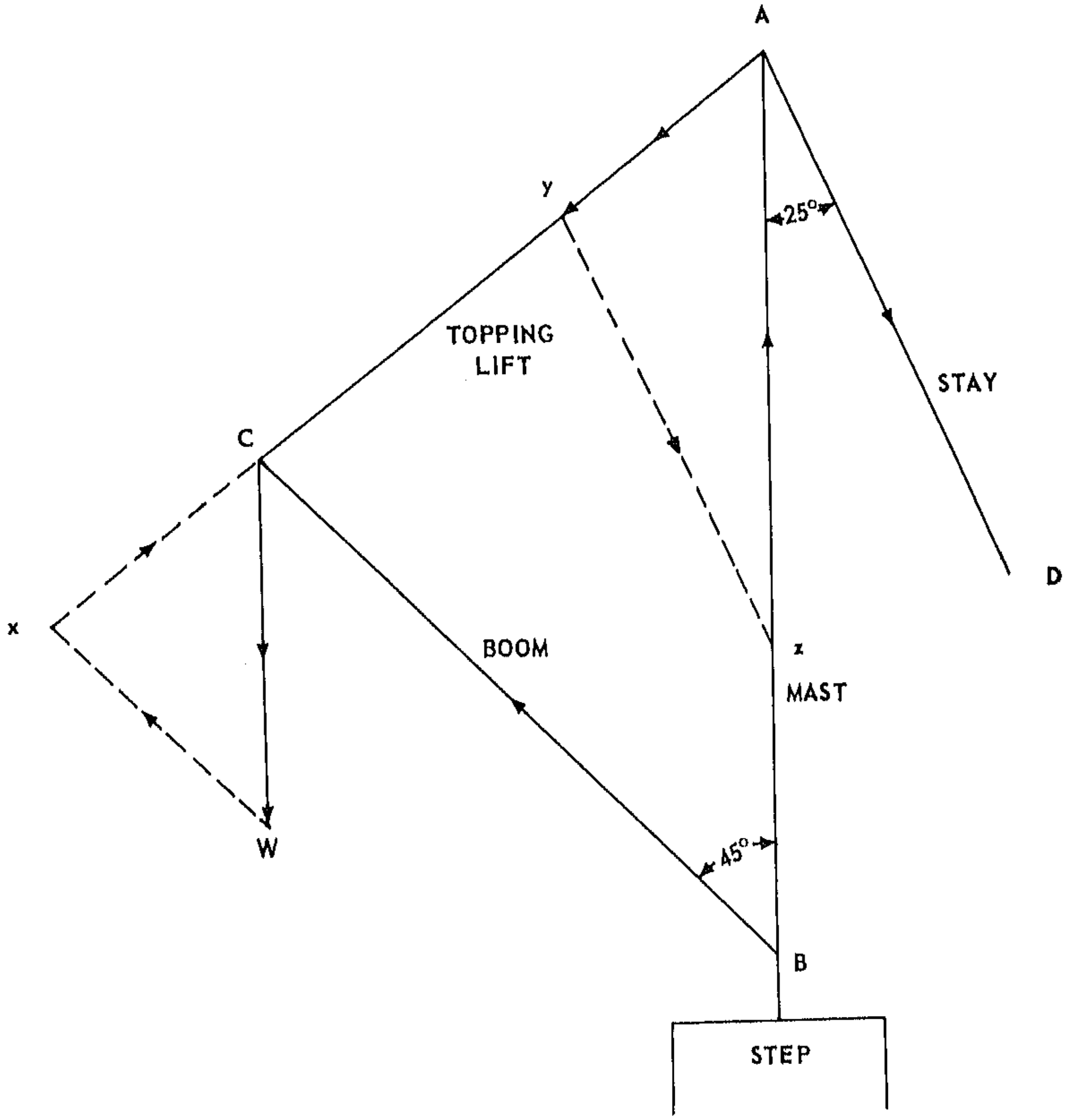
$$\frac{23}{16} \times \frac{1}{2} = \frac{23}{32}$$

$$\frac{23}{32} \times \frac{5 \text{ tons}}{1} = \frac{115}{32} = 3\text{-}19/32 \text{ tons}$$

Tension in the topping lift equals 3-19/32 tons or 7187.5 pounds.

We still must find the forces acting on the mast and the stay.

Because in problems of this type we must start with a force, let us decide with what force we have to work. Obviously, that of the weight is not logical, because it is so far removed from the part of the rig with which we are concerned. We do have, however, the tension in the topping



58.5(58D)

Figure 2-5.—The force triangle.

lift pulling on the top of the mast. Do not let the directional force arrows on legs Cx and Wx confuse you here, as they only indicate the type of force (tension or compression) the corresponding member is under.

We already know the tension in the topping lift is represented by 1-7/16 inches; therefore, from structure joint A we measure off 1-7/16 inches along AC and establish point y.

Ay now is our force vector and, of course, represents 3-19/32 tons.

For this portion of the problem, forget the weight 5 tons. This situation is as though the force on the top of the mast were being applied

by means of a line run to a winch. Our force here is the tension in the topping lift, 3-19/32 tons.

From point $\underline{y}$ we draw $\underline{yz}$ parallel to the stay, $\underline{AD}$, and draw the directional force arrows. The arrow on the mast points toward structure joint $\underline{A}$; therefore, the mast is under compression. If you transfer the arrow on leg $\underline{yz}$ to the stay, you can see that it is under tension, because it points away from the structure joint.

Leg $\underline{yz}$ measures 2-5/8 inches.

Therefore,

$$2\text{-}5/8 \div 1\text{-}7/16$$

$$\frac{42}{16} \div \frac{23}{16}$$

$$\frac{42}{\cancel{16}} \times \frac{\cancel{16}}{23} = \frac{42}{23}$$

$$\frac{42}{23} \times \frac{115 \text{ tons}}{32} = \frac{4830}{736}$$

$$\begin{array}{r} 6.56 \\ 736\,\overline{)4830.00} \\ \underline{4416} \\ 4140 \\ \underline{3680} \\ 4600 \\ \underline{4416} \\ 414 \end{array}$$

Tension in the stay is slightly less than 6.6 tons.

Similarly, $\underline{Az}$ measures 3-1/4 inches and compression in the mast is equal to around 8.2 tons.

GIN POLE OR STANDING DERRICK

A gin pole or standing derrick is a boom without mast or topping lift. It consists of a single spar with its butt resting in a shoe and its head held securely by manila or wire lines anchored to the deck or superstructure. The lines are usually guys rather than stays, because they are combined with tackles to permit change in the angle of the gin pole and corresponding horizontal movement of the load. There should be at least three guys, equally spaced in a semicircle behind the butt of the pole. A typical procedure for rigging a gin pole follows.

From the point at which the foot of the gin pole will rest, lay a line away from the direction of the load. This will indicate the position of the after guy. Lay two lines at right angles to the first (or nearly so) and at the same commencement point to position the side guys. For guy anchoring points choose bitts, cleats, pad eyes, etc., far enough away from the shoe to ensure that the guys will be at least twice the length of the pole.

Make the guys fast to the top of the spar. Use clove hitches and nail wedges to the spar to keep the hitches from sliding down. Lash the hoisting tackle above the guys. Brace the butt end at the back and both sides so it will not range along as you heave on the after guy to top up the pole (and later during the lift). When the head is high enough and all the guys are taut, you are ready to hoist. For heavy poles you might have to rig a light gin pole or a small pair of shear legs (discussed later) to start topping up the pole.

The foregoing description is for the simplest gin pole construction. It may be necessary, however, to add a forward guy to prevent the pole from toppling backward. That is apt to happen if, during use, the pole is raised to a near vertical position. Aside from its use as a safety measure, a forward guy increases the versatility of the rig. If the gin pole and load cross the vertical position, the forward guy then becomes the after guy with the same ability to control the position of the load as the original after guy. This permits a greater working radius.

FORCES ACTING ON A GIN POLE

The weakest part of a gin pole is likely to be the after guy (or backstay). Figure 2-6 shows you a formula for calculating the stress on the after guy in relation to a given weight. The rule may be stated thus: The shortest distance from the foot of the pole to the plumb line of the load, divided by the perpendicular distance from the

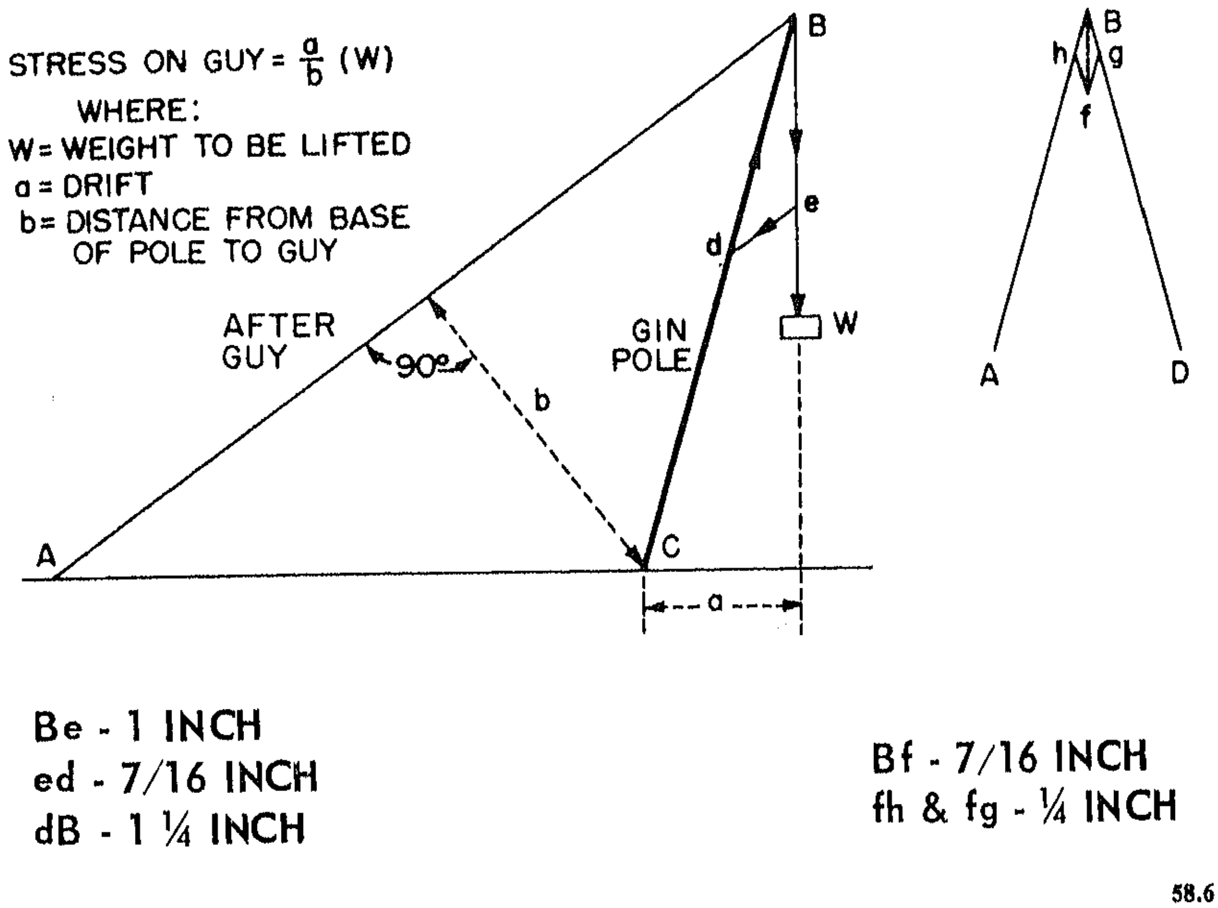


Figure 2-6.—Stresses on a gin pole.

guy line to the foot of the pole, is the percentage of the load on the guy.

Do not be misled into thinking the guy will never be under a stress heavier than the weight of the load. If you study figure 2-6, you will see that as the gin pole is slacked outward, distance b becomes less and distance a becomes greater than b. From then on, the guy is subject to a strain greater than the weight. This stress increases enormously as the pole approaches the horizontal and is so great as to be almost infinite when the pole is lying nearly flat. Obviously, then, the nearer the gin pole is to the vertical, the less the stress on the after guy, and the pole cannot be lowered very far off the perpendicular without setting up dangerous stresses.

The formula for finding thrust on the pole is complicated and it is much easier to use a force triangle. To construct your diagram, you must know or estimate three things:

1. Angle of the guy with the horizontal (BAC).
2. Angle of the pole with the horizontal (ACB).
3. Weight of the load.

Assume that figure 2-6 is a sketch of your rig and that the weight is 500 pounds.

Point B is your structure joint. Select a convenient scale (say 1 inch equals W), lay off line Be to represent W, and label it with an arrow pointing downward to indicate line of action. From point e lay off line ed parallel to BA (after guy). Mark lines ed and dB with arrows indicating lines of action. (Remember, arrows in

a force triangle always chase each other.) Now your force triangle is complete and you can measure the stresses in your rig as follows:

Line ed (tension on the after guy) = 7/16 inch = 219 pounds
Line dB (compression on the gin pole) = 1-1/4 inches = 625 pounds

You can easily see that in the vertical position the pole would be supporting a thrust equal to but no greater than the weight. As the pole is slacked outward, the thrust, like the stress on the guy, increases, reaching fantastic proportions when the pole approaches the horizontal.

Remember that a gin pole cannot be slacked very far off the vertical before it begins to take a very heavy strain.

In figure 2-6 consider the gin pole as having two after guys. To determine the tension on each guy, proceed in exactly the same manner to establish line ed. Line ed represents total tension. Now measure the angle between the two after guys where they meet at the top of the gin pole. Assume this to be 30° and construct this angle ABD (insert in figure 2-6). Bisect angle ABD with a line equal in length to line ed and establish point f. From point f draw line fh parallel to DB and line fg parallel to AB. The lines Bh and Bg represent the tension on each after guy in proportion to the total tension. These lines are 1/4-inch long.

Therefore, (1/4 ÷ 7/16) 219 pounds = 125 pounds. (This is just another way of writing a problem. It simply means that the portion of the problem included in the parentheses is to be multiplied by the number next to it. The multiplication sign, ×, is understood. Of course, the part within the parentheses must be worked out first. Thus, you solve this problem in the same manner as we have those that preceded it.

SWINGING DERRICK

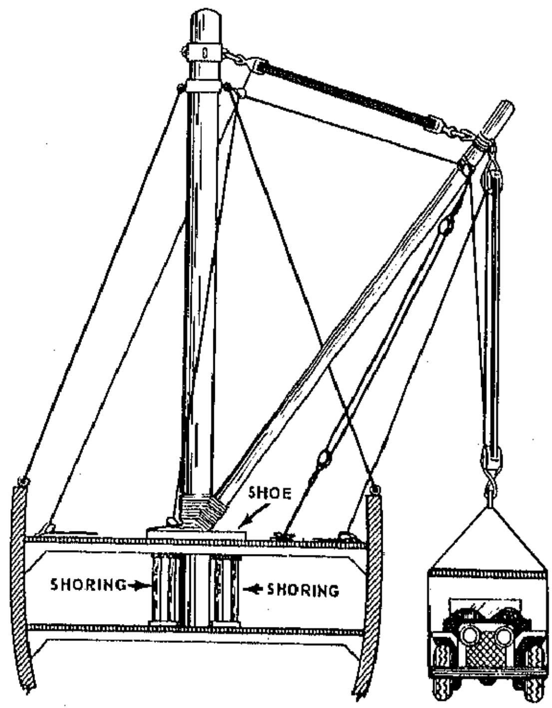
A swinging derrick is simply a gin pole attached to a mast, but the gin pole in this instance is called a boom. The butt of the boom is stepped to the foot of the mast in a manner which will permit both horizontal and vertical motion of the boom head. The head of the boom is attached to the upper part of the mast by a topping lift. The boom is topped up or lowered by this topping lift. The mast is supported by shrouds and stays, and the boom is swung horizontally by guys.

Figure 2-7 shows a jury-rigged derrick aboard a ship. The butt of the boom is stepped to the foot of the mast in this example, with the ship's standing rigging acting as backstays.

A variation of the swinging derrick rig is often used. The only difference is that the butt of the boom is stepped to the deck at some distance from the foot of the mast. Principles of operation are the same for both rigs, but this type has the advantage of preventing an unusually heavy thrust on the mast step.

In constructing a rig of this type, it is best to use the ship's mast as the rig mast. A jury mast may be rigged, however, if the ship's mast is not suitable. Two common procedures used to accomplish this are:

1. A hole is cut in the deck slightly larger than the jury mast planned, and the mast is



58.7

Figure 2-7.—A swinging derrick.

lowered through the hole until its foot rests on the deck below. The mast is held securely in a vertical position by a shoe of wood blocks bolted to the deck around the foot.

2. The jury mast is lowered through a hatch opening, and the foot secured to the deck below (as in the first procedure). Then the mast is braced firmly against one side (or corner) of the hatch by shoring or lashings led to the adjacent ship's structure.

A swinging derrick constructed to move a very heavy weight has two features not included in the ordinary rig: (1) a large shoe placed on deck under the heel of the boom, and (2) shoring installed to support the deck area under the shoe. Both the shoe and the shoring are illustrated in figure 2-7.

Heavy stresses are set up in all parts of the rig, especially in the boom thrust against the mast step. The shoe spreads the boom thrust over a wide deck area; the shores oppose the downward thrust of the mast.

FORCES ACTING ON A SWINGING DERRICK

Forces acting on a swinging derrick are: (1) thrust on the mast, (2) thrust on the boom, (3) tension in the topping lift, and (4) tension in the backstay(s). For a derrick rig with boom stepped to the mast, the following formulas may be used to determine stresses:

$$\text{Tension in the topping lift} = \text{weight} \times \frac{\text{topping lift length}}{\text{mast height}}$$

Mast height in these formulas means the vertical distance between the heel of the boom and the point on the mast where the topping lift is attached. Sections of the mast above and below these points are immaterial to the problem.

$$\text{Boom thrust} = \text{weight} \times \frac{\text{boom length}}{\text{mast height}}$$

$$\text{Tension in the backstay} = \text{weight} \times \frac{\text{backstay length}}{\text{mast height}} \times \frac{\text{horizontal distance from mast to end of boom}}{\text{horizontal distance from mast to backstay anchoring point}}$$

Bear in mind in the above that it is horizontal distance from the mast to the end of the boom; that is, to a point directly under the head of the boom.

To reduce your computations to a minimum, take advantage of every mathematical shortcut. One such shortcut that will speed up your calculations and cut down on your chances of making arithmetical errors is cancellation.

To illustrate this process, let us set up a hypothetical situation and figure the tension in the backstay. Let us suppose that we have the following:

Weight	750 pounds
Length of backstay	24 feet
Height of mast	20 feet
Horizontal distance from mast to backstay anchoring point	15 feet
Horizontal distance from mast to end of boom	10 feet

Then, we can write our problem and work it as shown below.

$$\frac{\overset{150}{\cancel{750}}\text{ lbs} \times 24' \times \cancel{10'}}{\underset{2}{\cancel{20'}} \times \underset{3}{\cancel{15'}}}$$

divide by 5

$$\frac{150\text{ lbs} \times \overset{12}{\cancel{24'}}}{\cancel{2'} \times 3'}$$

$$\frac{150\text{ lbs} \times \overset{4}{\cancel{12'}}}{\cancel{3}} = 150 \times 4 = 600\text{ lbs}$$

Notice that 15 goes into 750 with no remainder. If you can see this quickly, fine! However, in problems like this, do not waste time trying to determine such things. You can divide as often as necessary to get the smallest dividend possible.

Notice, too, that the feet signs (′) cancel out, leaving pounds the only possible unit for the answer. This technique may not seem worthwhile in this problem, but in those with several different units you may not be sure just which unit your answer includes. In those cases, it pays to include all units in your problem and cancel them out. If your problem is written correctly, you will end up with only one unit.

The force triangle method of solving these problems has an advantage over the formulas in that the stresses in all parts of the rig may be determined by working only one problem.

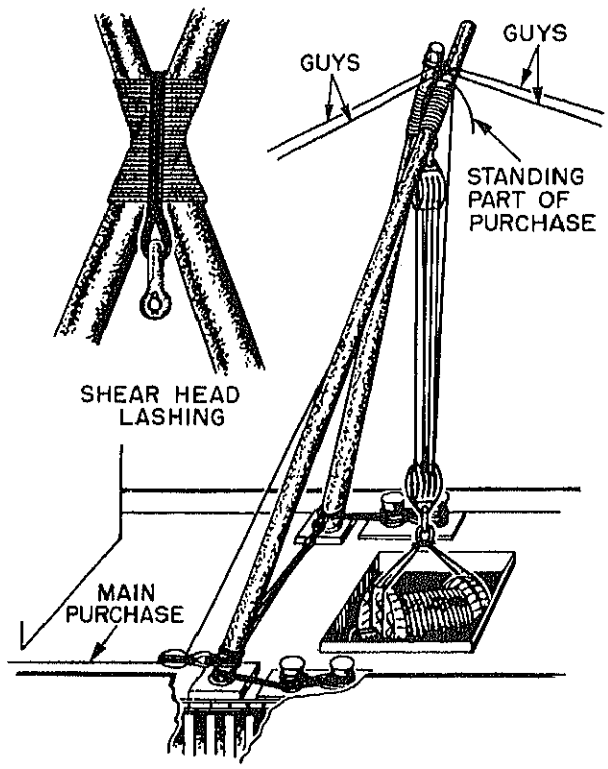
SHEARS

Shears are, in effect, a pair of gin poles lashed together and set up in an inverted V-shape to resemble a huge pair of shears. Figure 2-8 illustrates shears rigged on a ship's deck. Here is a suggested method of rigging shears:

Lay two spars of suitable strength on deck, butts close together. Pass a clove hitch around one spar about 3 feet from its head, and pass the rest of the lashing 10 or 15 times around both spars above the clove hitch, leaving enough slack in the turns to permit the shear legs to open. Take a couple of frapping turns around the lashing, and finish off with a clove hitch around one of the spars.

The butts of shear legs should be no farther apart than about one-third the length of one of the spars. Open out the butts, place the shoes, and attach the hoisting tackle in a sling around the lashing. Shoes should rest on planking to distribute the thrust over a large deck area. It may even be necessary to shore up the deck beneath the butts of the shear legs.

Secure the guys to the spars with clove hitches. Raise the shears by the most practicable means available. Then rig a tackle between the butts of the shear legs to keep them from being spread by the load. Guys attached to the shear head work in conjunction with the hoisting tackle to permit limited lateral movement of the load.

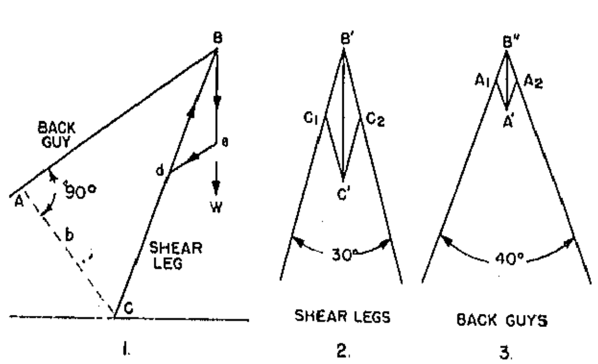


58.8

Figure 2-8.—Rigging shear legs.

FORCES ACTING ON SHEARS

Figure 2-9 (view 1) is a side view of a shear leg rig with line BC representing the thrust line of action on the shear legs and line



58.9

Figure 2-9.—Stresses on shear legs.

BA representing the tension line of action on the after guys. Proceed exactly as you did in the gin pole problem in figure 2-6, and construct your force triangle Bed.

Use any convenient scale and select any weight (W). Find the tension (T) in the stays and the compression (V) in the legs. The values that you find, T and V, are resultants of the tension in each guy and compression in each leg. You now must find the individual stresses (views 2 and 3 of figure 2-9).

That is done in the same fashion as in the cargo whip problems (figure 2-1). Remember, the force you are working with in each case is the resultant—not the original weight.

If your rig has a single after guy, you may solve for tension by using the formula shown in the gin pole problem (figure 2-6). However, with shears the perpendicular distance, b (figure 2-9) is measured from a point midway between the butts of the shear legs.

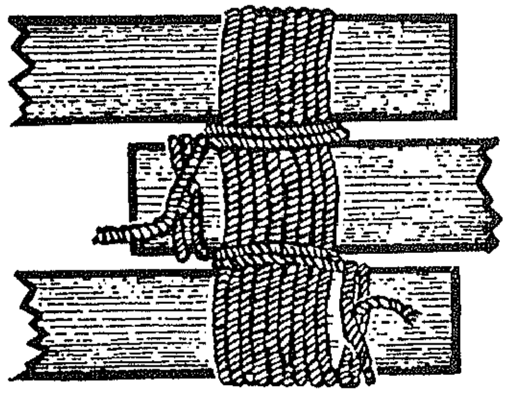
There is still another force in a shear leg rig, the one which tends to spread the shear legs. To keep this force within the safe limits, confine the distance between legs to not more than one-third the length of a leg. Run a lashing or a tackle between the legs to keep them from spreading.

TRIPOD

A tripod is the strongest of all jury rigs. Its only disadvantage is it cannot be manipulated to move the load horizontally. It is of simple construction, consisting of three spars lashed together and set up to form a tripod.

About the only difficult part is lashing the spars together at the head. Figure 2-10 shows you how this is done.

Lay the three spars on deck so their ends dovetail, as in the illustration. Pass a clove hitch around one of the outer ones, then take 10 to 15 turns around the three spars. Take a couple of frapping turns around the lashing between the spars, and wind up with a clove hitch around the center one.



58.10

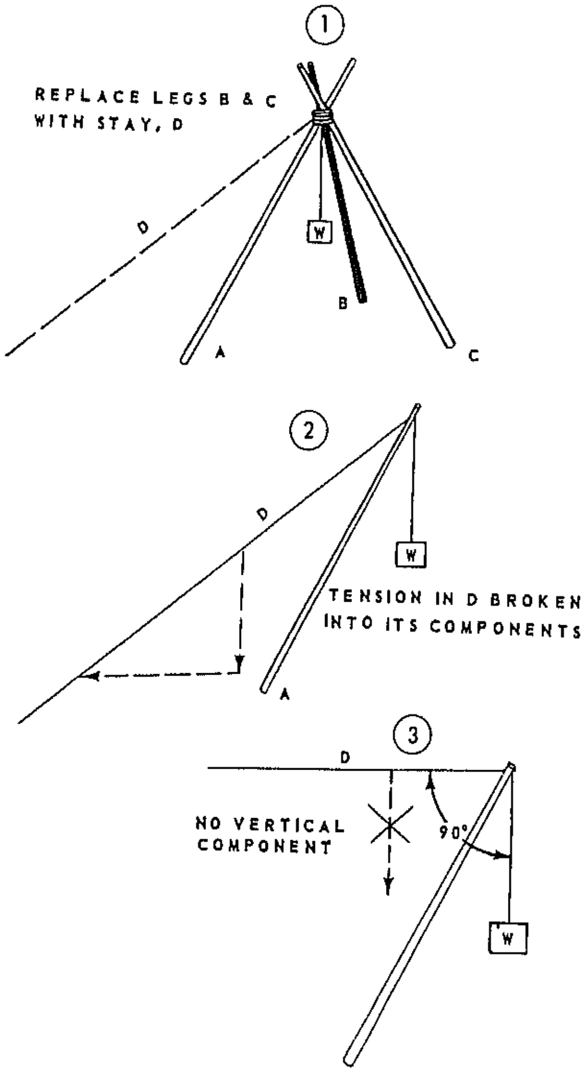
Figure 2-10.—Lashing spars together for a tripod rig.

The sides of the equilateral triangle formed on deck by the butts of the legs of the tripod should be no less than one-half nor more than two-thirds of the length of each leg.

FORCES ACTING ON A TRIPOD

You have no guys to be concerned with in a tripod. As the thrust is distributed over three spars, you are fairly safe if each spar used is capable of a thrust equal to the weight to be lifted. You counteract spreading effect by confining the distance between legs of the tripod to not more than one-third of the length of each leg. If you desire to know the thrust on each leg of a tripod, compute the thrust on one leg, as for a gin pole, with a backstay at right angles to the plumb line of action of the weight. This will give you total thrust for the whole rig. Divide by 3 to obtain thrust for each leg.

You can figure this problem as though there were a stay at a right angle to the line of action of the weight if you consider the stay as taking the place of the other two legs. See figure 2-11. If the stay were erected at any angle other than perpendicular to the line of force (view 2), the stay would take a portion of the downward thrust. However, as we move the stay closer to the horizontal (that is, perpendicular to the line of force), the vertical component gets smaller and smaller, disappearing when the stay is 90° from the line of force (view 3).



58.11
Figure 2-11.—Why thrust in a tripod can be computed as though a horizontal stay supported a single leg.

PARBUCKLING

Parbuckling is a convenient method of hoisting or moving cylindrical objects up a ramp (view A, figure 2-12) or up a vertical surface (view B). The cylinder, in effect, provides the equivalent of two or more sheaves. Each has its own line, called a runner. The number of sheaves depends on how many runners are in use. A runner has a mechanical advantage of 2. Thus, a heavy cylindrical weight can be rolled up a vertical or inclined plane when hoisting equipment is not available.

Whenever possible it is to your advantage to make use of an inclined surface in conjunction with a parbuckling rig. The rule regarding such planes is: The ratio of force to weight is equal to the ratio of height of the plane to its length along the incline. So you can see that an inclined plane is a simple machine and has a definite mechanical advantage. To increase the pulling power, a two- or even threefold tackle may be clapped on the runner.

Let us examine the various force factors of this rig in the form of a problem. There is a 2000-pound propeller shaft on a barge alongside that must be loaded aboard, and you wish to know how much pull it will take to handle this load using a parbuckling rig with two runners. It is possible to construct an inclined plane from the deck of the barge that will be 20 feet long for a vertical rise of 10 feet. This will give you a mechanical advantage of 2:

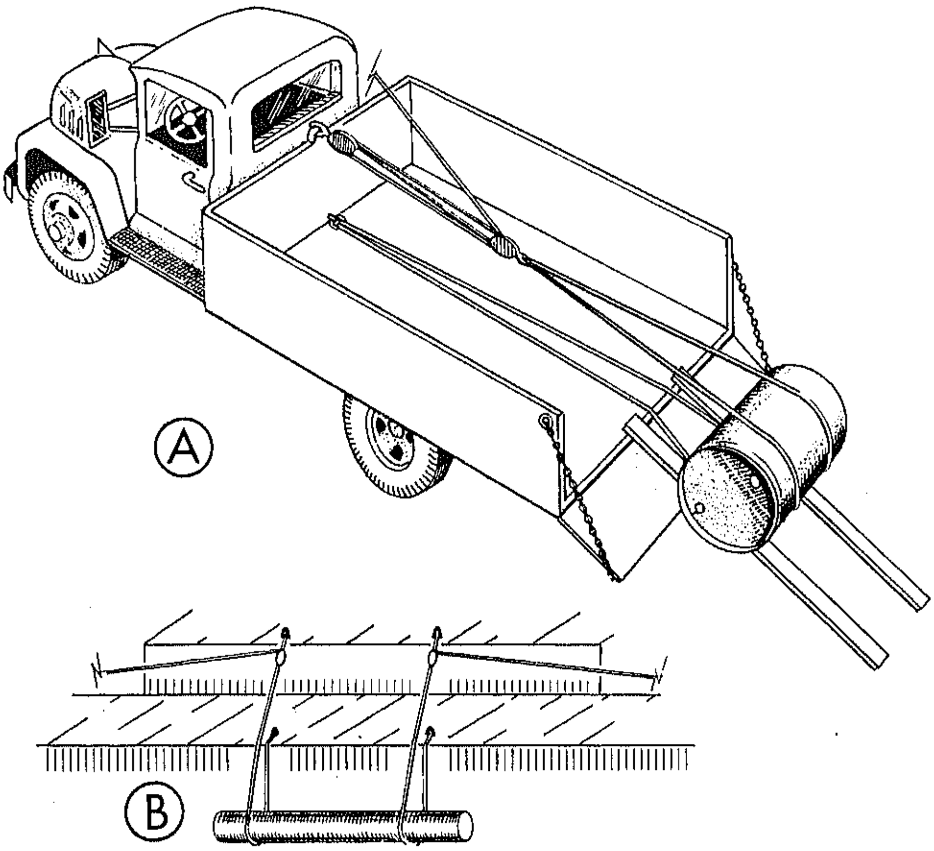
$$MA = \frac{\text{Length}}{\text{Height}} = \frac{20}{10} = 2$$

This reduces to 1000 pounds the force required to move the weight. You know that the mechanical advantage of the rig is 2, so that reduces the force to 500 pounds. With two runners sharing the load, the required pull on each runner is 250 pounds. Now, by clapping a twofold tackle on each runner, with a mechanical advantage of 4, force required is further reduced to 62-1/2 pounds. Disregarding friction, this is the pull required on each tackle.

ACCESSORIES FOR HANDLING HEAVY WEIGHTS

Following is a brief description of some of the gear used in supporting or handling heavy weights, together with suggestions for its use. Remember that it may be necessary to shore up the deck from below before setting down a heavy lift.

Skids are planks used to distribute weight over a greater area to provide a smooth surface



58.12(58D)

Figure 2-12.—Parbuckling rig.

for skidding a load, or to provide a runway surface when rollers are used.

Cribbing consists of piling timbers or shoring in alternate tiers crossing each other. A firm and level foundation is the first consideration in cribbing. The bottom pieces must rest firmly and evenly upon the deck, arranged in such a way as to distribute the weight over several transverse frames.

Rollers of either hard wood or iron must be cylindrical in shape. Lengths of large pipe make excellent rollers.

If the under surface of the weight to be moved is irregular, planks must be used above as well as below the rollers. In making a turn on rollers, front rollers must be inclined in the direction of the turn and rear rollers in the opposite direction.

Chocks are wedges made in various shapes to fit the particular weights to be handled. Scotches are wedges whose upper surfaces are rounded for chocking guns, wheels of vehicles, and other round objects.

A cradle is built to hold a gun, boat, or similar object when it is being stowed or moved on rollers. It is a framework of timber or metal frames, connected by crosspieces of transoms shaped to receive the object.

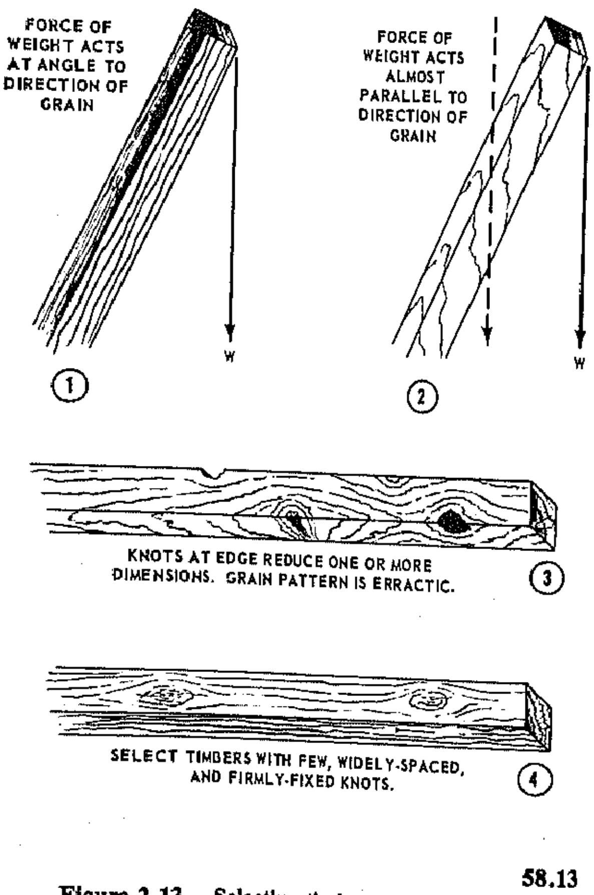
SELECTING TIMBERS FOR THE JOBS

Now that you know how to determine the stresses set up in various parts of weight handling rigs, the question (an important one in

jury rigging) that naturally follows is what will support the load? Aboard ship where you probably will use shoring timber, your chief problem will be to determine the proper size, because all shoring timber is (or should be) of the best grade. On a shore station, however, you are likely to be required to make your selections from several different grades, some of it very poor. Therefore, you must know what to look for.

Many factors must be considered. In addition to the kind and size of timber, probably the two most important factors are direction of grain and number and location of knots.

Direction of grain is important because, in most rigs, timbers stand or are operated at an angle from the vertical. Hence, the force we have referred to as compression actually works in part as a shear force; that is, it tends to cause the spar to shear off horizontally.



58.13

Figure 2-13.—Selecting timbers for jury rig.

In the strongest timbers, the grain runs generally along the longitudinal axis as shown in view 1 of figure 2-13. The timber in view 2, with the grain running at an angle across the longitudinal axis, is much weaker than the other and, therefore, less suitable for any rig.

The problem of knots is illustrated in view 3. Knots at the edges of a timber effectively reduce the timber's strength, because they actually reduce one or more dimensions of the timber. Therefore, if you must use timbers with knots (and you probably will have to) select those timbers in which the knots are in the middle, spaced far apart, and firmly fixed. (See view 4 of figure 2-13.) Do not use pieces that are cracked or checked.

To Find the Strength of a Spar

Spars are an integral part of all the jury rigs, and you must know how to determine the thrust a spar will stand without buckling. To solve for this factor, let T equal the safe thrust in tons, R, the radius of the spar in inches (with rectangular timbers, use the smaller dimension), and L, the length of the spar in feet. Then the formula for safe thrust is:

$$T \text{ (tons)} = \frac{4R^4}{L^2}$$

This formula contains a value raised to the fourth power. To square a number, you multiply it by itself. To raise it to the third power, you multiply the result by the original number again. To raise it to the fourth power, you do the same thing once more.

$$2 \times 2 \times 2 \times 2 = 16$$

You get the same result if you square the number and then square your answer.

$$2^2 = 4$$

$$4^2 = 16$$

Here is how to find the safe thrust on a 17-foot spar with a 10-inch diameter. (When you

substitute values in the formula remember that radius is one-half diameter.)

$$T = \frac{4 \times 5^4}{17^2}$$

$$T = \frac{4 \times 625}{289}$$

$$T = \frac{2500}{289} \text{ or about } 8.6$$

This spar, then, will stand safely a thrust of about 8.6 tons.

The multiplier 4 (the number before the R) in this formula is suitable for all common types of wood. The computed strength may be increased by 50 percent when very strong woods, such as ash or oak, are used.

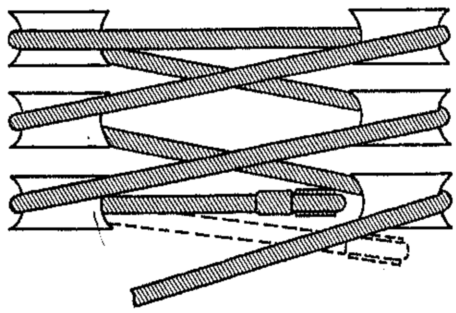
REEVING FALLS

It is imperative when reeving falls that the pattern used is such as to reduce friction to a minimum and thus ensure greater longevity of the rope or line.

You should already know from experience that reeving a single whip, runner, gun tackle, luff tackle, or twofold purchase presents no particular problem. However, when there are three or more sheaves in one or both blocks in a tackle, there is a definite problem. If the pattern is not right, some parts may rub against each other, hastening the coming of the day when the tackle is no longer safe and must be rerove. However, you must never change a ship's rigging plan without proper authority.

In most tackles there is no single "right way," for the correct pattern depends on the construction of the blocks and on the use to which the tackle will be put. Do not forget that a rig, to be most effective, must be tailored to fit the need. What is ideal for one task may be useless or even disastrous for another.

It is preferable in all tackle reeves to have the standing part in alignment, or nearly so, with the hauling part. The standing part of the fall should be reeved through the blocks before splicing it around the becket thimble. Many



29.187(58C)A

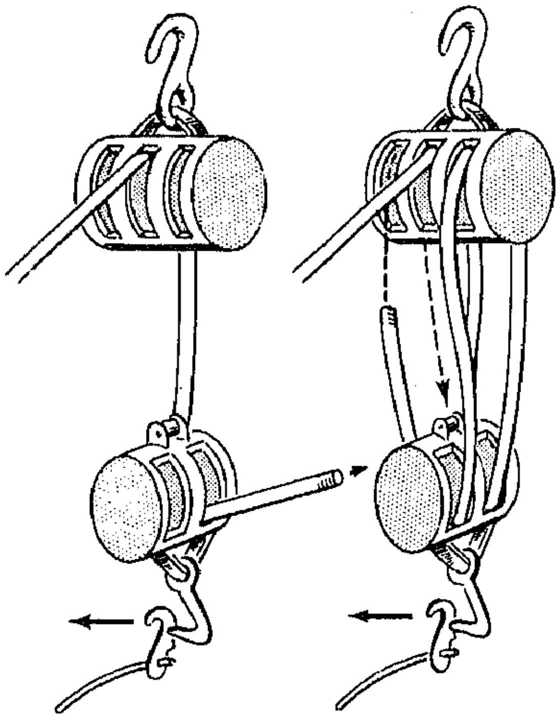
Figure 2-14.—Reeve pattern of a parallel threefold tackle.

blocks of three or more sheaves have a design that permits shifting the becket or becket shackle to a new position on the block. The new position may be on the side of a cheek or under a sheave (figure 2-14). This feature lends itself readily to a change from one reeve pattern to another.

It is said that a three sheave-two sheave (double luff) tackle or two three-sheave combinations (threefold purchase) always are so reeved as to place one block at right angles to the other. In either case, the hauling part of the fall is reeved through the middle sheave of a three-sheave block. To do otherwise would cause the block to cant (tip). However, it is not always a right-angle pattern that can fit the need. Other patterns, with little or no cant, are tailored to fit a need.

Figure 2-15 shows the pattern for reeving a right-angle double luff, and figure 2-16 illustrates a right-angle threefold tackle. These two tackles are excellent for boat falls that have no swivel hook. Such falls, properly rigged, permit the hook of the lower block to lay in a fore-and-aft alignment with a boat. The right-angle reeve should never be used on topping lifts. Incidentally, when reeving falls in a right-angle pattern, it facilitates the process to stand one block on its cheek and lay the other (usually the one with the becket) down.

Figure 2-14 is a parallel threefold tackle with the becket and hauling part in alignment with each other. The slight amount of cant to the upper block is of no significance. But, if the becket were under the center sheave or on the



29.187(58C)B
Figure 2-15.—Reeving a right-angle double luff.

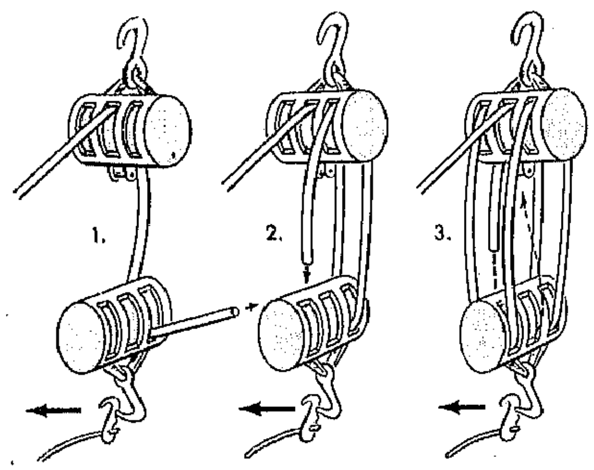


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Figure 2-16.—Reeving a right-angle threefold tackle.

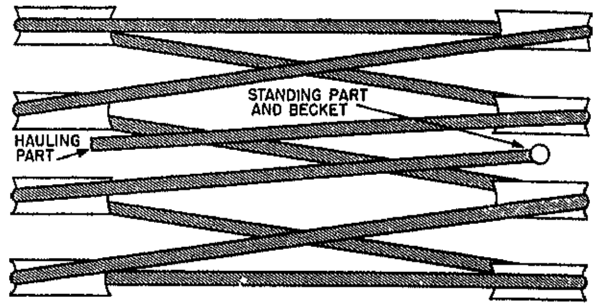

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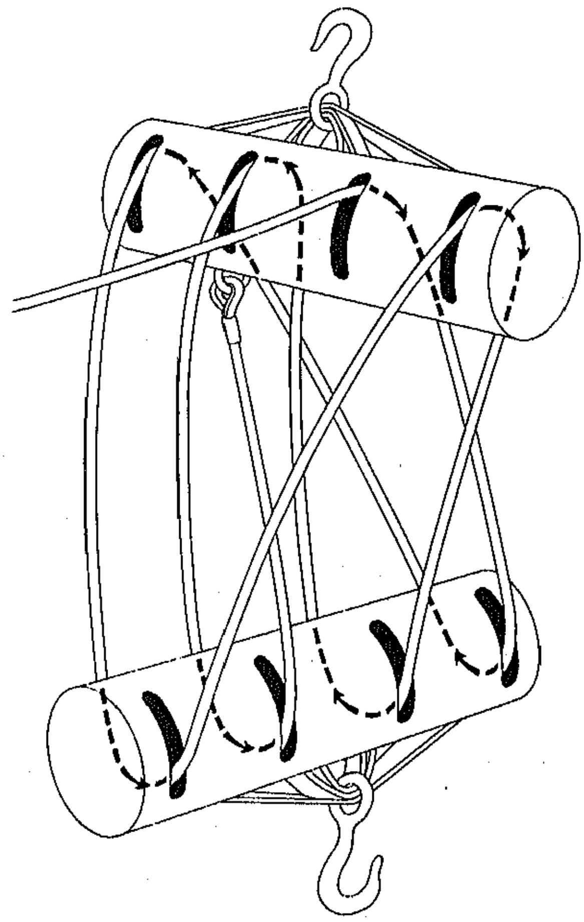
Figure 2-17.—Reeve pattern of a parallel fourfold tackle.



29.187(58C)E
Figure 2-18.—Reeve pattern of a right-angle fourfold tackle.

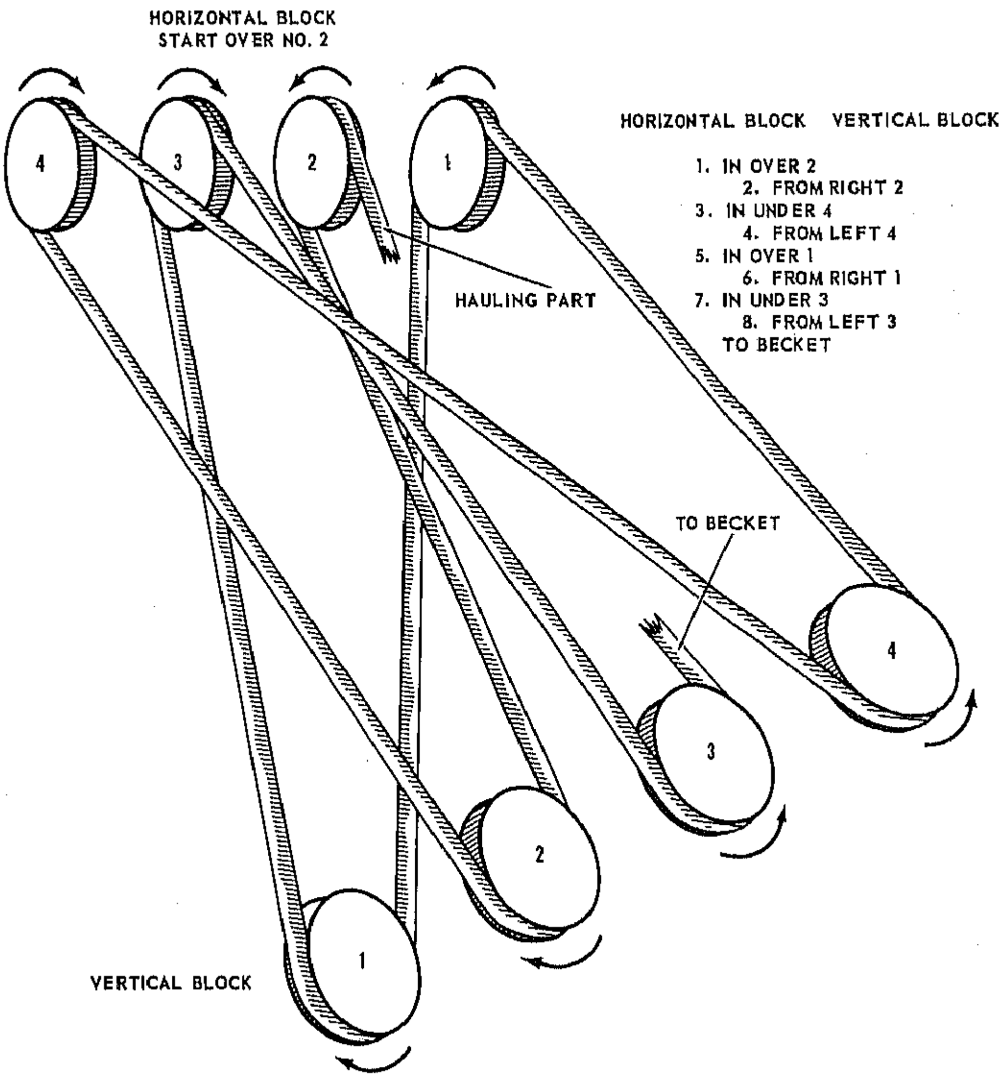
sheave farthest from the hauling part, with the hauling part remaining outboard, the cant would be considerable.

The parallel threefold pattern and similar ones may be used as topping lifts. It is useful as boat falls when the lower block is equipped with a swivel hook. The latter use makes it easy to observe whether the falls are fouled before hooking on.

A parallel fourfold tackle with its becket and hauling part near the center is shown in figure 2-17. There is no cant because the load is evenly distributed over all sheaves. This tackle may be used for any heavy lifts within computed safe working loads; for boat falls, a swivel hook is required.

In comparison to figure 2-17, figure 2-18 shows a right-angle fourfold tackle. This tackle should NEVER be used as a topping lift but is very useful for heavy cargo or boat falls.

Another right-angle reeving pattern for a fourfold tackle (figure 2-19) is taught at the Naval Diving and Salvage Training Center in Panama City, Fla.



29.187(58C)F

Figure 2-19.—Another right-angle reeve pattern for a fourfold tackle.

If you imagine you are standing behind the vertical block, the terms "right" and "left" in the illustration are understandable. Sheaves in the vertical block are numbered from bottom to top and those in the horizontal block, from right to left as indicated.

Start reeving by running your line over number 2 sheave of the horizontal block; then from the right, around number 2 sheave of the vertical block, and so on as shown.

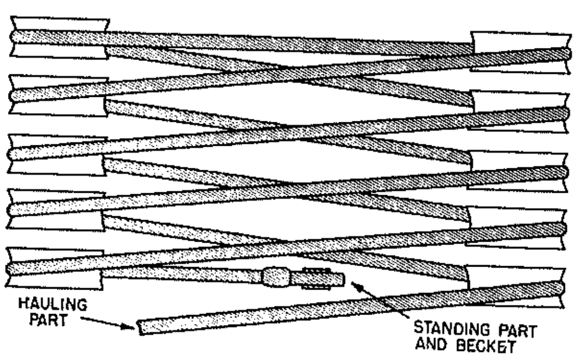
The following key will help you to remember this particular pattern. The key is not difficult if you think of the relationships 2-4, 1-3, over-under, and right-left.

Also remember the starting point and the numbering of the sheaves.

Horizontal	Vertical
Over 2	Right 2
Under 4	Left 4
Over 1	Right 1
Under 3	Left 3

Figure 2-20 illustrates one pattern of a parallel fivefold tackle. It is especially useful for jumbo boom topping lifts where the hauling part can be fairled only from the side of the block. It may also be used as a boat fall but, here again, a swivel hook must be included with the lower block.

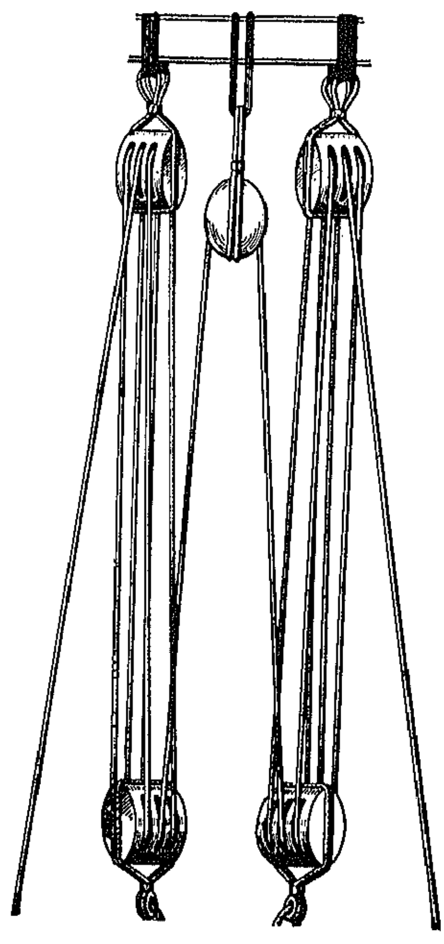
There are other tackle patterns, but those discussed here are the most flexible of all possible reeves and are strongly recommended for any load within the safe working load of the line or rope and the blocks. When you train personnel, emphasize that parallel reeves can be used with the same effectiveness as right-angle reeves. In any reeve, if the folds cross each other, chafing will occur. If any of the folds enters the swallow at a side angle, jams will result. In an excessively canted position, the lines will chafe at each swallow and cause excessive wear and strain, including a possible jam, with resultant casualty to material and personnel.



29.187(58C)G
Figure 2-20.—Pattern for a fivefold reeve.

SPANISH BURTONS

Occasionally it is necessary to hoist a load that exceeds the capacity of any tackle at hand.

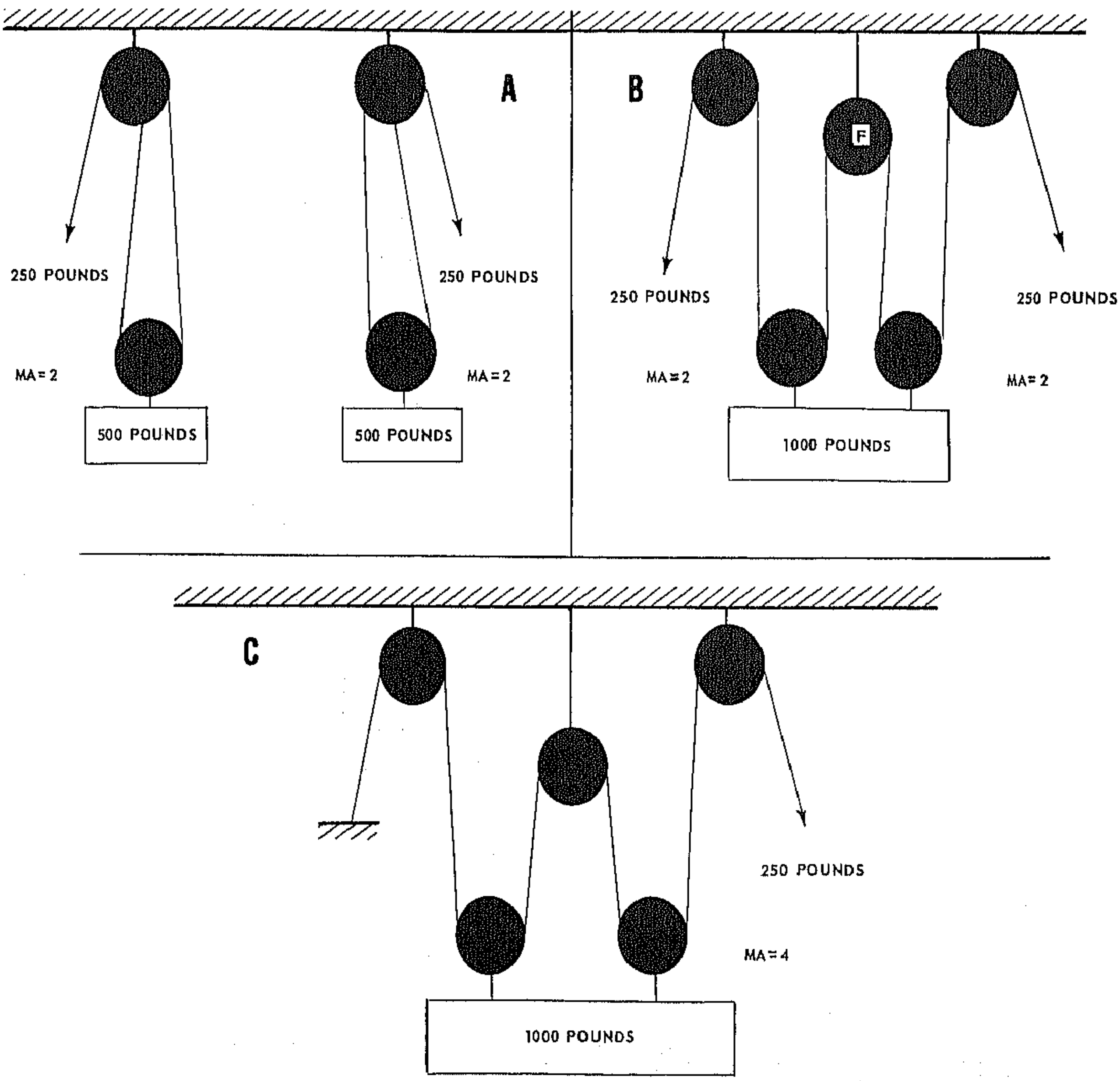


59.187(58C)H
Figure 2-21.—Rigging two tackles with a continuous fall.

Of course, you could rig two tackles that together would be strong enough to accomplish the work. However, if you also were short of power you would gain a power advantage by rigging a Spanish burton, or continuous fall, such as that shown in figure 2-21.

It may be difficult to understand how such a rig gives a power advantage over two tackles; therefore, let us consider the situation in figure 2-22.

In view A, it is obvious that with the mechanical advantage (MA) of 2, 250 pounds



29.187(58C)J

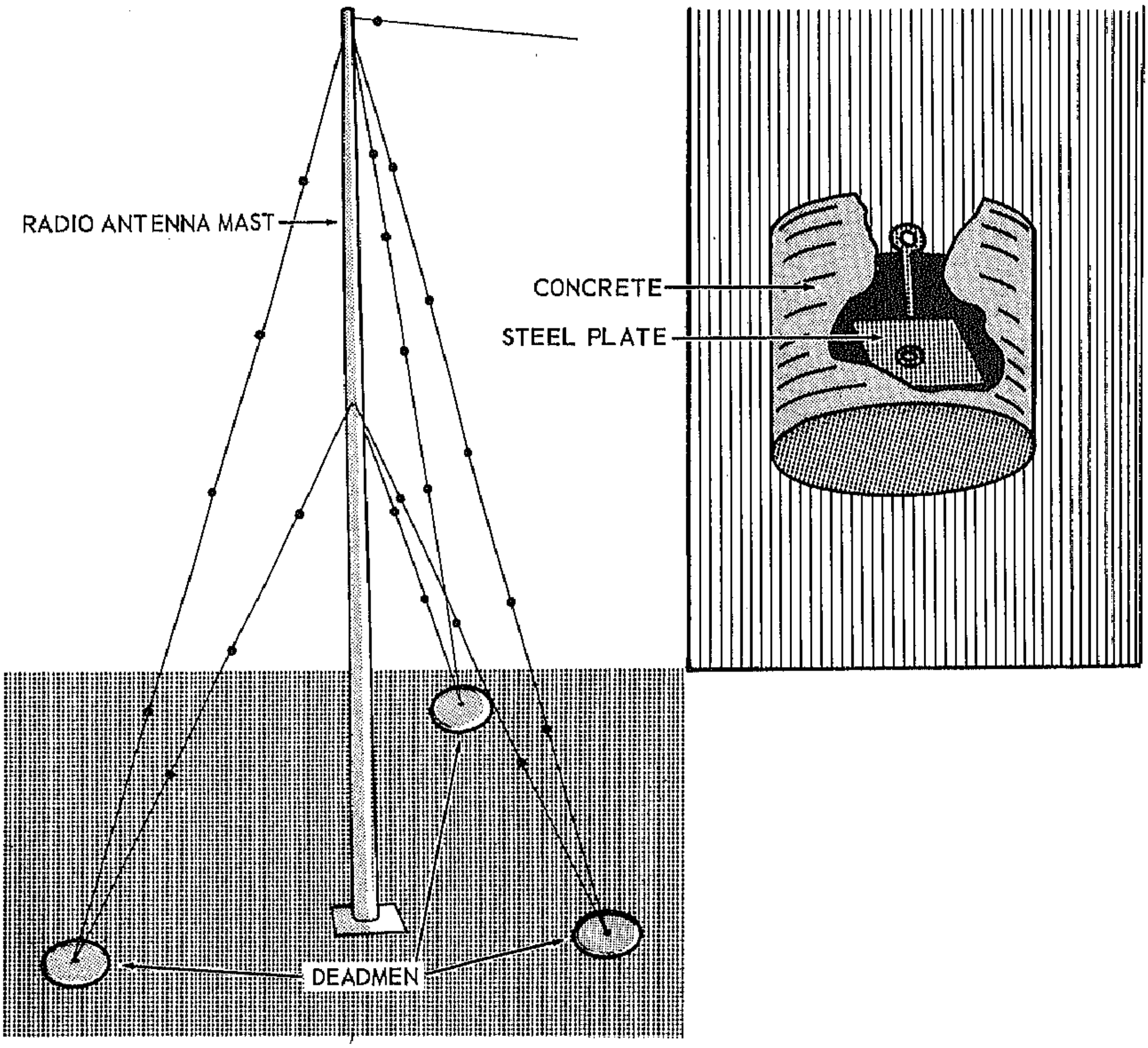
Figure 2-22.—Advantages of a Spanish burton rig.

pull on each of the hauling parts will lift the two 500-pound weights. (Throughout this discussion we will disregard friction.) It also is easy to see that if the two 500-pound weights were replaced by one of 1000 pounds, the two 250-pound forces still would lift the load.

Now consider view B. For the sake of this discussion, let us say that the line is secured at the center fairlead (F) block instead of being rove through it. We would then have two whips and runners with MAs of 2 and still need 250 pounds of force on each hauling part.

Reeving the line through the fairlead block does not alter the MAs. We still need the two 250-pound forces.

What happens, however, if we secure one hauling part (view C)? Do we now need a 500-pound force on the other in order to hoist



58.14

Figure 2-23.—Construction and use of deadmen.

the load? Not at all. You can see by inspection that the MA now is 4. Hence, we need only 250 pounds of force to do the same amount of work.

ANCHORAGES FOR STAYS AND GUYS

One problem when rigging is to find places to secure stays, guys, fairlead blocks, etc.

Aboard ship this problem is not so prevalent because one can use bases of gun mounts, davits, hatch coamings, bitts, chocks, and so on. To obtain the most advantageous leads, spars and other timbers or bridles can be secured between available strong points.

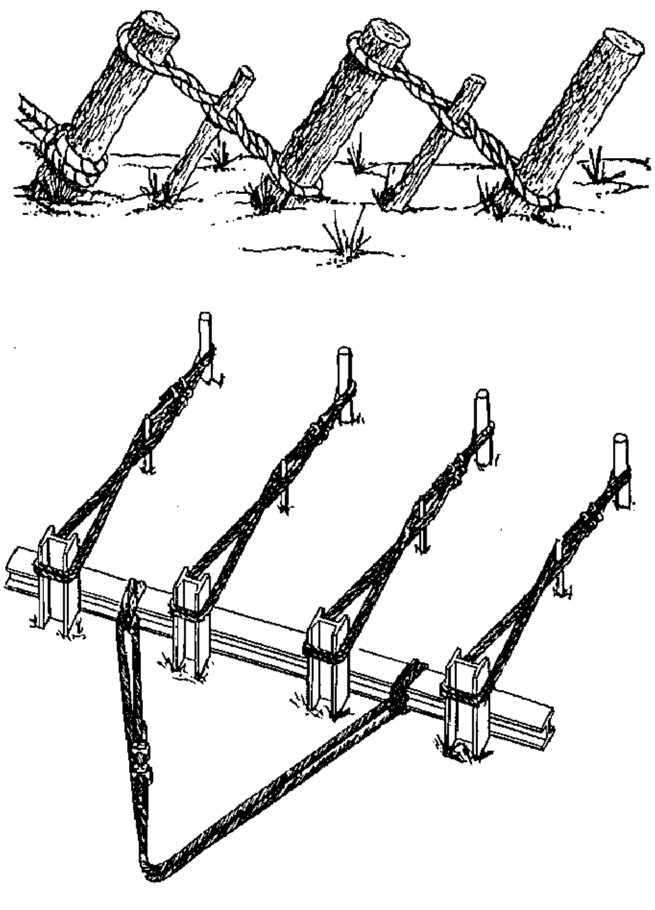
Ashore there are trees, outcroppings of rocks, pilings, and other sturdy, manmade structures. In open fields or on beaches, however, a great deal of ingenuity may be required to devise adequate anchorages.

If the rig is to be more or less permanent, concrete deadmen can be constructed beforehand and set in holes dug for the purpose. See figure 2-23. Of interest in this respect—dry concrete weighs about 150 pounds per cubic foot.

Figure 2-24 shows two methods of using stakes driven into the ground. Notice that both use Spanish windlasses to transmit a portion of the strain to other stakes. The stakes used for levers in the Spanish windlasses should be sharpened so they can be driven into the ground after the lines have been tightened.

Small boat anchors and small concrete deadmen buried in sand have surprising holding power if the vertical angle of the strain is not excessive. If the vertical component of the strain is great or the strain is particularly heavy, you can construct a rig, such as that shown in figure 2-25, from a sheet of plywood or planks and several 4x4s or other timbers and bury the rig in the sand. A similar arrangement is the log-in-ditch anchorage shown in figure 2-26.

There also are available patented anchors such as those used by light and telephone



29.198(58C)A
Figure 2-24.—Anchorages for stays, guys, etc.

companies to anchor the stays of their poles. These anchors are designed so they can be screwed into the ground at the desired angle.

Because conditions vary so greatly, do not depend on any type of anchorage until you have tested it.

If it is necessary to drag a heavy piece of equipment into a room or compartment, tackles and fairlead blocks can be attached to timbers placed across doorways and windows. In frame buildings, the timbers must be long enough to spread the strain over several studs.

If there is no door, window, or other rugged fixture opposite the opening through which the item must be drawn, it may be possible to set up and use a timber in the manner shown in figure

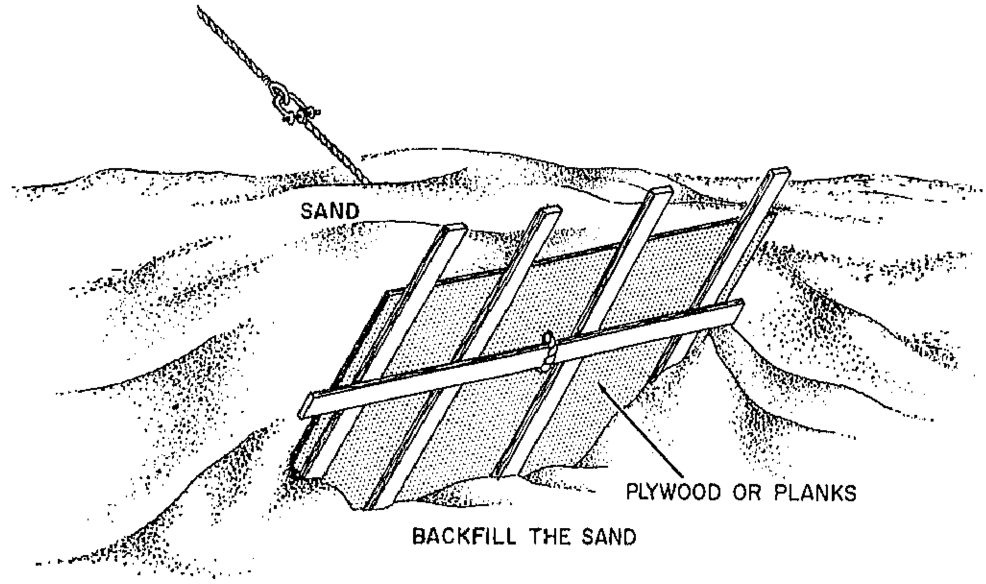


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Figure 2-25.—One type of anchorage to use in sand.

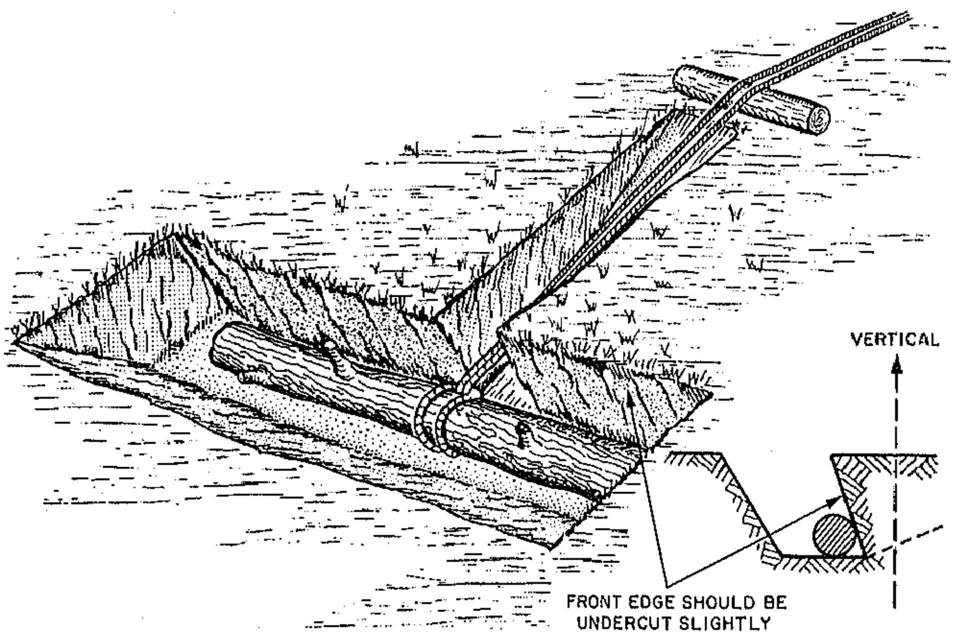

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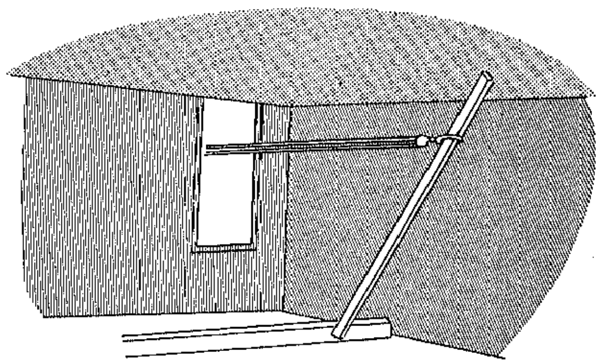
Figure 2-26.—Log-in-ditch anchorage.



58.15

Figure 2-27.—One method of securing a tackle or fairlead block within a building.

2-27. If necessary, this timber may be reinforced by shoring to the bulkhead.

FINDING LENGTHS OF STAYS

Another bit of mathematics that is useful to the rigger is the Pythagorean (pi-thag-o-rean) theorem:

> In a right triangle, the square of the length of the hypotenuse is equal to the sum of the squares of the lengths of the other two sides.

(The hypotenuse, of course, is the side of a right-angled triangle that is opposite the right angle.)

This theorem can be used in many ways, but its most frequent application by a rigger is to determine the length of stays.

For example, let us assume that we are about to erect a radio antenna mast such as that shown in figure 2-23. Suppose that the mast is 80 feet high and that the deadmen are to be placed 30 feet from the base of the mast. What is the length of the longer set of stays?

If we call the distance to the deadmen side $\underline{a}$, height of mast, side $\underline{b}$, and the hypotenuse (length of stay), side $\underline{c}$, we can write our theorem in formula form as:

$$c^2 = a^2 + b^2, \text{ or}$$

$$c^2 = 30^2 + 80^2$$

Then,

$$900 + 6400 = 7300$$

Because 7300 is the square of the hypotenuse, we must find its square root.

8 5
$\sqrt{73 \ ' \ 00}$
64
165/ 9 00
8 25

Length of stays equals 86 feet plus enough extra to attach the wire clips.

Another way of writing the formula for the Pythagorean theorem is as follows:

$$c = \sqrt{a^2 + b^2}$$

Now let us suppose that the other set of stays is to be attached to the mast at a point 55 feet above the ground and to the same deadmen as the longer set. Work out your own figures, then check them against those that follow.

$$c = \sqrt{a^2 + b^2}$$

$$c = \sqrt{30^2 + 55^2}$$

$$c = \sqrt{900 + 3025}$$

$\sqrt{39 \ ' \ 25}$
36
122/3 25
2 44

Length of shorter stays equals 63 feet plus enough extra to attach wire clips.

WIRE SPLICING

Boatswain's Mates are required to know how to short and long splice wire rope. Like many other skills, wire splicing is much easier learned if someone shows you how. By carefully following these instructions, however, you should be able to learn the techniques involved.

SHORT SPLICE

The first step in short splicing wire is to place temporary seizings on each rope 2 or 3 feet from

the ends, depending on the size of the rope. The distance from the end to the seizing should be approximately equal to 36 times the diameter of the rope. After seizing, unlay the ropes and tightly tape or whip the ends of the strands. Interlace the strands, as is done with fiber line. Force the two pieces of rope as tightly together as possible, and seize them in place. Cut the temporary seizing from one rope and begin tucking the strands of the other rope into that rope.

Tucks go against the lay, over one strand and under two. Take four rounds of tucks, then split each strand and bend half of each back out of the way. The halves bent back are dropped at this point. Take two more tucks with the other halves. Next, turn your wire, cut off the other temporary seizing, and repeat the foregoing steps in the opposite direction.

Beat out the splice with a wooden mallet, working from the center to the ends and turning the splice as you beat. To complete the work, cut off the strands and beat down the ends.

LONG SPLICE

The recommended number of feet to make a long splice in wire is 40 times the diameter of the

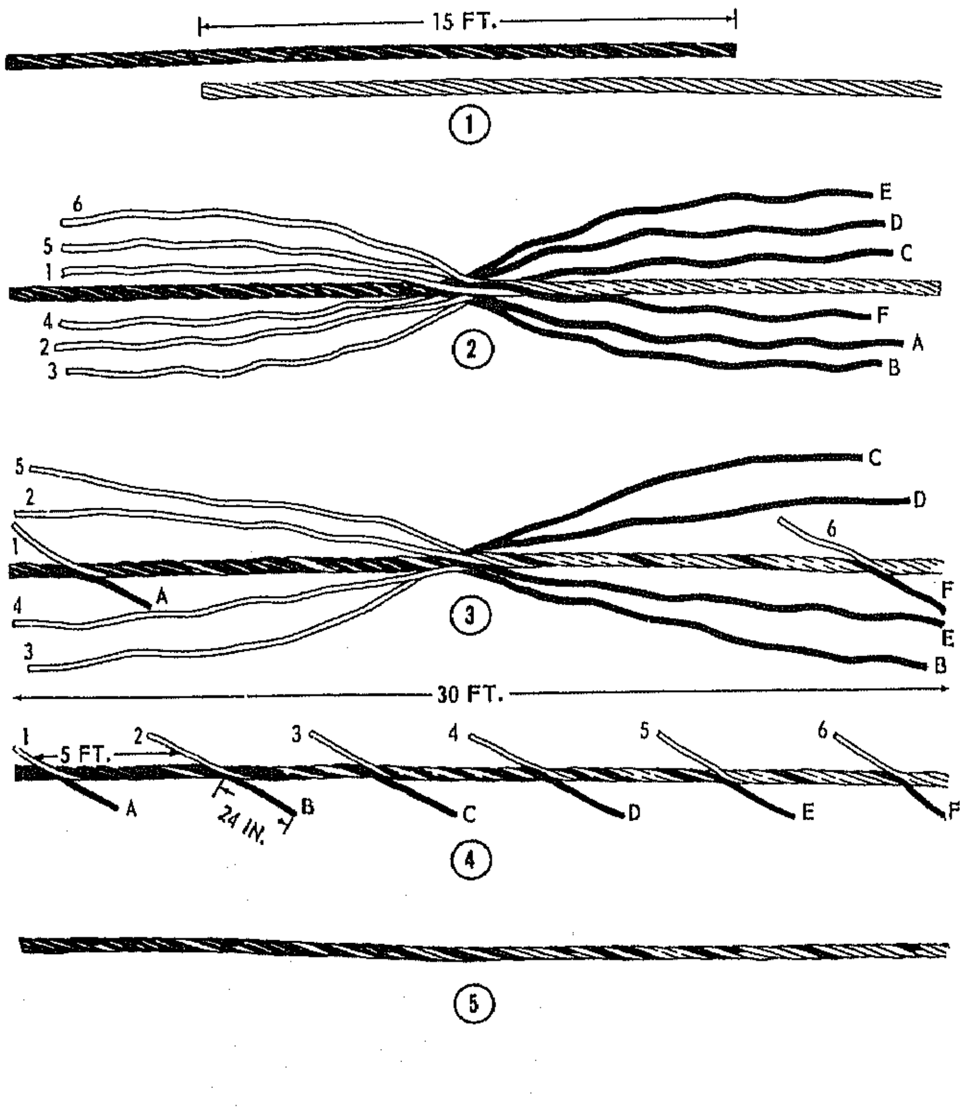


Figure 2-28.—Making a long splice in wire.

wire. In other words, a long splice in 3/4-inch wire would cover a distance of 30 feet, 1/2-inch wire would be 20 feet, and so on. For the following explanation, 3/4-inch wire, or a splice of 30 feet, is used.

Measure 15 feet from the ends of each wire and put on temporary seizings (figure 2-28). Cut the end seizings, unlay, and whip the strands. Cut out the core, interlace the strands, and butt the ends of the rope together solidly and seize in place. (See step 2 in figure 2-28.)

Step 1: Cut off the temporary seizing on one rope and start unlaying any one of the strands, laying the opposite strand from the other rope in the groove as you go. Lay in all but 2 feet of this strand and cut off all but 2 feet of the unlaid strand.

Step 2: Repeat step 1, but work in the opposite direction, unlaying the strand next to the strand laid in step 1. That gives you a strand laid in each direction.

Step 3: Repeat step 1 with the next strand of the first rope, stopping 5 feet short of the meeting point of the first pair. Continue unlaying and laying in successive strands, working first one way and then the other, leaving 5-foot intervals between the meeting points. When all strands are laid in, your splice should like that in step 4 of figure 2-28.

One method of securing the ends of a long splice is the same as for fiber rope. Tie an overhand knot and pull it taut. Then divide the ends in three parts and tuck them separately as shown in figure 2-29.

The preferred method of securing the ends is illustrated in figure 2-30. Tuck the ends of the

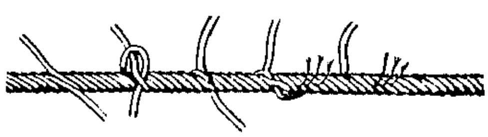


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Figure 2-29.—One method of securing ends of a long splice.

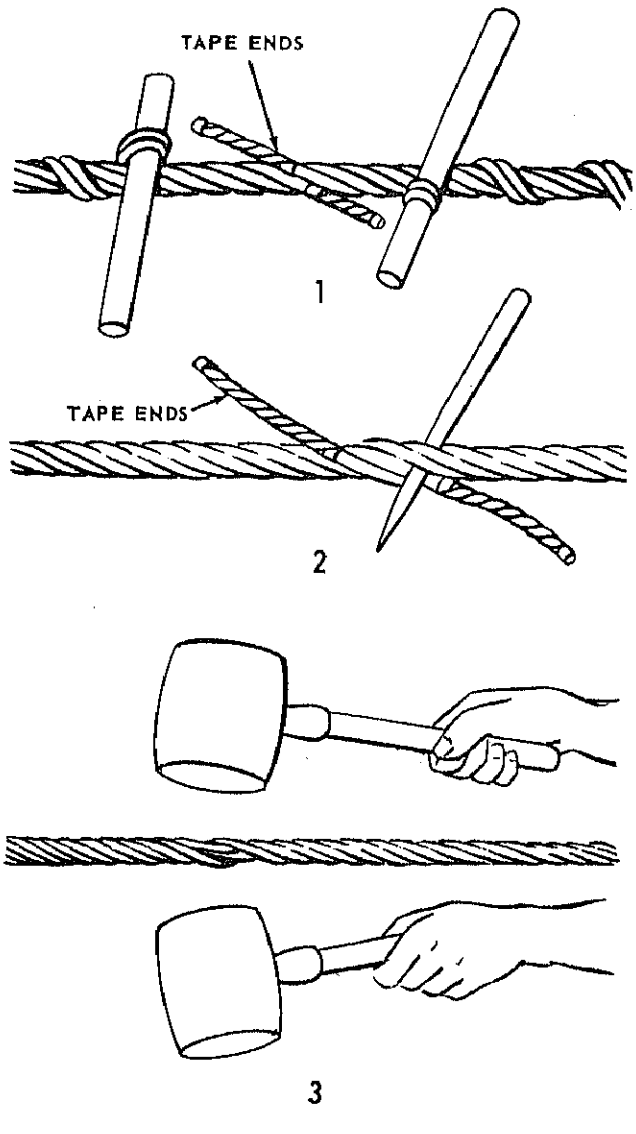

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Figure 2-30.—Preferred method of securing ends in a long splice.

strands into the rope, replacing the core. Seize the strands at their meeting point and cut off the end whippings. Untwist the strands so the "form" or "set" is taken out. Next, build up the strands to the same size as the core. That may be done with successive seizings of seizing wire if it replaces a wire core. If the rope has a hemp core, serve the strands with marlin or wrap them with friction tape.

Secure a Spanish windlass on each side of the meeting point as in step 1 in figure 2-30. Twist in opposite directions, opening the lay of the rope. Cut the core and pull out the ends a few inches. Shove a marlinspike under two adjacent strands as in step 2. You now can take off the Spanish windlasses. Work the spike along the rope, pulling out the core and laying in the strand until all the strand is in. Then cut off the core at that point and shove the end back in place and pull out the spike. Repeat the process on all the other strand ends. Notice that the strands do not cross before tucking. After securing the ends, beat out the splice as in step 3. A long splice with the ends secured in the manner described does not alter the size of the rope, and will almost defy detection after the rope is in use a short time.

CHAPTER 3

CARGO HANDLING

Cargo-handling rigs, associated equipment, their use, and cargo-handling safety precautions were discussed in *Boatswain's Mate 3 & 2*, NAVEDTRA 10121-G. The general viewpoint was that of the worker.

In this manual we are concerned with cargo handling from the standpoint of the supervisor. We discuss such subjects as cargo-loading plans, training personnel, and the like. Our primary concern is with cargo handling and loading as they apply to amphibious operations.

CARGO LOADING

In the Navy today, four general types of cargo loading are in use—administrative, commodity, selective, and combat.

Administrative loading, used only for nontactical movement, deals primarily with the efficient use of troop and cargo space without regard for tactical consideration. After the equipment and supplies have been unloaded, they must be sorted before they can be used.

Commodity loading is a method of loading each type of cargo in a space by itself in such a way that it can be discharged without disturbing other cargo. It is the type of loading used most frequently on replenishment ships.

In selective loading, cargo destined for particular units is isolated where it can be unloaded quickly and, if possible, without disturbing cargo intended for other units.

Combat loading gives primary consideration to the facility with which troops, equipment, and supplies can be unloaded ready for combat on landing, rather than to using ship space to best advantage.

There are three methods of combat loading—combat unit loading, combat organizational loading, and combat spread loading. They differ mainly in degree of availability of troop units for landing and in the tactical integrity (completeness) of the units.

In combat unit loading, all or an integral part of a combat unit, such as an assault battalion landing team with its essential equipment and supplies, is completely loaded in a single ship in such a manner that, upon landing, it is immediately ready to support the tactical plan. This method provides the maximum flexibility for meeting possible changes in tactical plans.

Combat organizational loading is the method in which a unit with its equipment and initial supplies is loaded into a single ship, together with other units, in a way that permits unloading in a predetermined order.

Combat spread loading is the method of loading in which some of the troops, equipment, and initial supplies of a unit are loaded in one ship and the remainder are loaded in one or more other ships. This method commonly is used for troop units with heavy equipment.

CARGO-LOADING PLANS

Regardless of what type of load is to be made, a loading plan always is prepared to guide the crews who load and stow the cargo. Taking into account the type of load contemplated and assuming that the loading plan was prepared properly, the plan ensures that:

1. The greatest possible use is made of available space.
2. All cargo is loaded.

3. Heavy cargo is stowed in holds served by equipment that can handle it.
4. Cargo is accessible at points or times that it is to be unloaded.
5. Time for loading and unloading is reduced to a minimum.
6. The load will not cause a list or undesirable trim.

Loading plans are based on the ship's loading characteristics pamphlet, a tabulation of the principal characteristics of the ship. It lists such things as ship's speed, length, beam, troop accommodations, and a detailed breakdown on the specifications for each cargo stowage space. An important part of the ship's loading characteristics pamphlet is a scaled plan view of each cargo stowage space showing square feet of deck space, hatches, locations of stanchions and other obstructions or irregularities, overall dimensions, bale cubic capacity, and clearances under beams and hatch coamings. Notations indicate which spaces are suited for gasoline, ammunition, vehicles, and pyrotechnic stowage.

Naturally, a loading plan for an administrative load differs from that for a combat load, but from the standpoint of the cargo handlers and their supervisors, the difference is relatively unimportant. Let us, therefore, consider only the combat loading plan.

COMBAT LOADING PLANS

Staff officers specially trained in the techniques of planning and supervising loading for an amphibious operation are assigned to landing force organizations, major amphibious ships, and to naval staffs within the amphibious forces. In the landing force, such officers are called embarkation officers; in the naval organization, ship or staff combat cargo officers.

Combat loading plans are prepared by a team of embarkation officers assisted, when possible, by the combat cargo officer. Plans and later changes to them must be approved by the embarkation team commander and the ship's commanding officer.

Loading plans have many parts, but of chief interest to the cargo handlers and their supervisors are the stowage diagrams and the profile loading diagrams.

Stowage Diagrams

Stowage diagrams (figure 3-1) are drawn to scale and show graphically the placement of cargo aboard ship, giving the exact location of vehicles and cargo within each cargo hold. In addition to the graphic presentation on the diagram itself, the items contained in each cargo hold are listed in manifest form on the bottom or on the reverse side of the stowage diagram (figure 3-2).

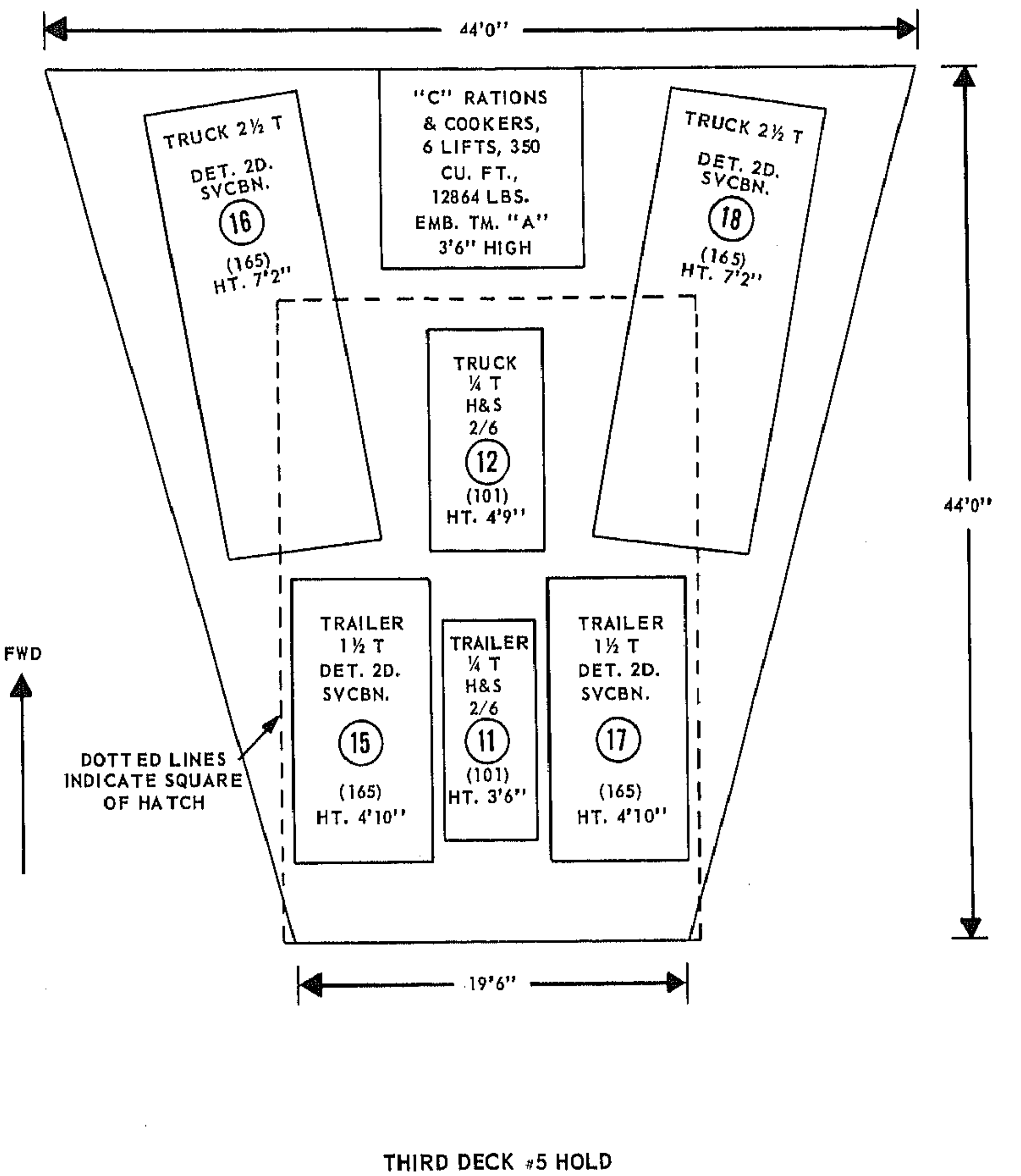
Compare the manifest with the stowage diagram. Notice that priority numbers on the latter are circled and that serial numbers appear in parentheses. Priority numbers, of course, show the order of unloading. Serial numbers identify troops and equipment that are to be landed at the same place at approximately the same time. Serial numbers also simplify communications in regard to troops and equipment. A troop commander need only call for a certain serial to be landed at a specified beach, and the desired component, together with its gear, will be received.

Profile Loading Diagram

The profile loading diagram (figure 3-3) is a distorted profile view of the ship showing holds and compartments in which cargo is stowed. Items that go into the troop berthing spaces also are shown on this diagram.

The number preceding the item indicates the estimated number of lifts required to load or unload the item. The number following the item shows the total weight of that particular group. The numbers in parentheses below each vehicle entry show the order in which the vehicles will be unloaded. Usually, other cargo is not unloaded in any specific order but is taken out as it is made accessible.

These diagrams and the manifest can be used to determine which cargo-handling gear must be rigged at each hatch and if and when the rig must be changed to another.



HATCH OPENING OVERHEAD:	21'8" X 32'9"	MINIMUM CLEARANCE:	10'9"
CLEARANCE TO COAMING:	10'0"	SQUARE FEET:	1,397
CLEARANCE TO GIRDERS:	10'2"	CUBIC FEET:	13,990
CLEARANCE TO BOARDS:	12'3"	BOOMS:	2 10-TON, 1 35-TON

58.16

Figure 3-1.—Stowage diagram.

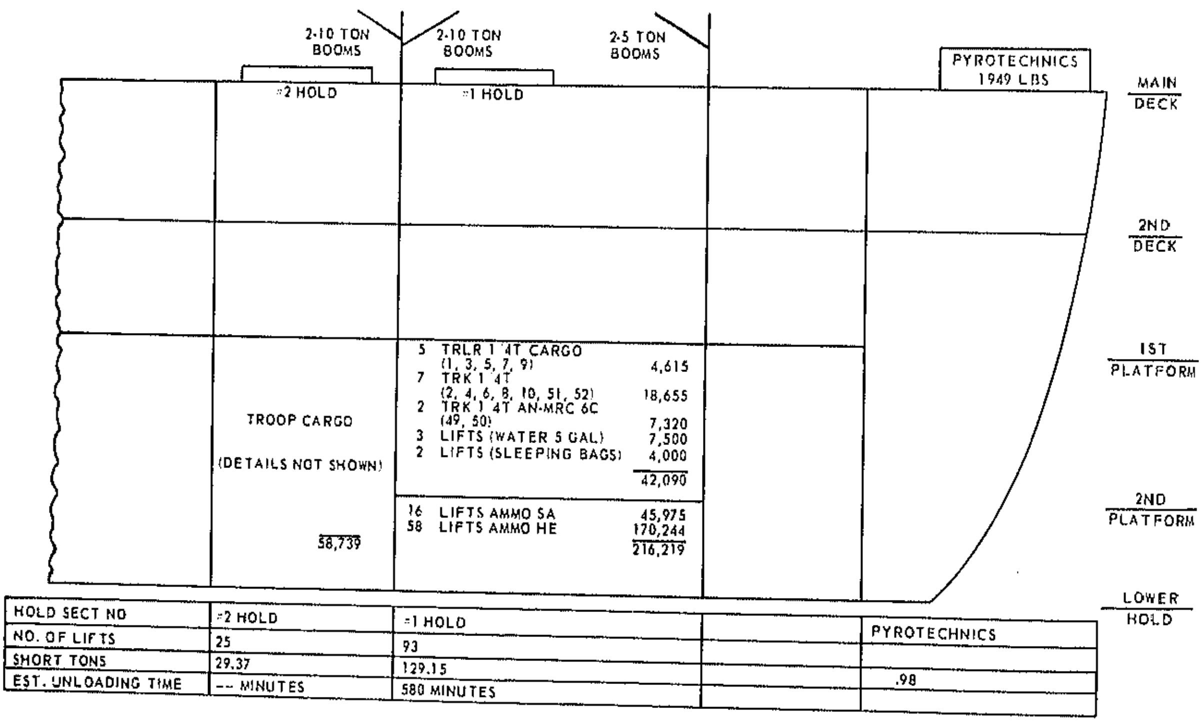
CARGO MANIFEST

SHIP THIRD DECK #5 HOLD

SERIAL	PRIORITY	DESCRIPTION	ORGANIZATION	LIFTS	CU FT	GROSS WT
101	11	TRAILER ¼ T	HQ 2/6	1	42	965
101	12	TRUCK ¼ T	HQ 2/6	1	276	2665
165	15	TRAILER 1 ½ T	DET 2NDSVCBN	1	464	3400
165	16	TRUCK 2 ½ T	DET 2NDSVCBN	1	1753	16060
165	17	TRAILER 1 ½ T	DET 2NDSVCBN	1	464	3400
165	18	TRUCK 2 ½ T	DET 2NDSVCBN	1	1753	16060
	BULK CARGO					
	A	RATS, INDIV. & TRIOXANE	EMBTEAM	6	350	12864
TOTAL				12	5207	42550

58.17

Figure 3-2.—Cargo manifest used in conjunction with stowage diagram.



58.18(58D)

Figure 3-3.—Profile loading diagram.

LOADING

Loading is the combined responsibility of the ship's company and the ship's platoon, a part of the embarkation team advance party. The embarkation team advance party, which also includes cooks, guards, policing (cleaning) details and the like, comes aboard several hours before loading begins. The ship's platoon, usually made up of personnel trained in handling cargo, works on the pier and in the holds. Trained officers and noncommissioned officers supervise personnel and see that all cargo is loaded in its proper sequence. Naturally, this sequence is in the reverse order of unloading.

The advance party provides shoring and dunnage, special slings, and lashings in excess of that furnished by the ship.

Police details usually are left aboard to assist in cleaning the ship after the main body of troops has departed.

Responsibilities of the Ship's Company

Ship personnel make provisions for lighterage and landing craft; ensure that all spaces are ready for troops and cargo; provide winchmen, hatch tenders, hatch officers, and additional cargo handlers; and furnish cargo nets, slings, steadying lines, and lashings. The first lieutenant and, therefore, every Boatswain's Mate involved, shares with the ship's platoon the responsibility for seeing that the cargo is loaded and stowed in accordance with the approved loading plan. Ship's personnel alone are responsible for securing the cargo, but the ship's platoon normally assists with the work.

UNLOADING

The amphibious task force commander's responsibility for unloading usually devolves upon the ship's commanding officer and the troop debarkation officer (ordinarily the team embarkation officer or an assistant). Acting for the commanding officer of troops, the troop debarkation officer (TDO) states troop requirements for unloading to the first lieutenant, ship's debarkation officer (normally the combat cargo officer), and other ship's officers.

The TDO is the troop representative during the unloading operation, and assists and advises the ship's debarkation officer (SDO) as required. The TDO stations a checker at each hatch to maintain a running record of cargo unloaded and the beaches to which it is sent. After the commanding officer of troops leaves the ship, the TDO makes decisions for the troop commander in regard to unloading.

A part of the ship's platoon, known as hatch unloading details, works in each hold under the supervision of their officers and NCOs.

Responsibilities of Ship's Company

The ship's debarkation officer (SDO) acts for the CO and is responsible for debarking troops in accordance with the debarkation schedule and unloading cargo in accordance with the unloading plan. A primary function of the SDO is to have the proper landing craft at the designated station. The SDO's station is on the bridge, from which communication with the aft signal station, each debarkation station, and each hatch is maintained. A checkoff list of landing craft, their loads, destinations, and times of departure is also maintained at the SDO's station.

The ship furnishes the following personnel for each hatch:

1. A hatch officer (commissioned officer or a petty officer) who supervises the unloading, ensures that the coxswain of each boat knows the route and distance to the destination, and informs the SDO when (1) ready to load a landing craft, (2) landing craft is nearly loaded, (3) landing craft clears the station, and (4) there is a delay in unloading.

2. A hatch talker who relays messages between the hatch officer and the SDO.

3. Two complete, trained cargo-handling details for each hatch, including winchmen, hatch tenders, and Boatswain's Mates. Two details are necessary to ensure that unloading operations can continue without interruption.

Unloading Plan

To unload cargo in a certain sequence, it must be loaded in reverse sequence. Planning for unloading, therefore, is conducted concurrently with planning for loading. When the embarkation team commander approves the loading plan, the schedule of priorities for unloading is determined at the same time.

The troop debarkation officer prepares the detailed unloading plan and briefs unloading personnel on its contents before reaching the objective area.

There is no standard form for the unloading plan, but some of the more important requirements are:

1. Enough information to ensure that cargo unloading priorities established by the embarkation team commander are followed.
2. Types of cargo in each hold.
3. Type of landing craft required for unloading each hold and their reporting sequence.
4. Special instructions for unloading, such as those necessary when using craft other than the ship's.

Unloading Periods

Unloading during an amphibious assault is divided into two periods, initial and general. The initial unloading period is tactical in character, and the operation must be instantly responsive to troop requirements ashore. The term "selective" describes the unloading operations during this period, because items are selected and off-loaded according to priority or in response to a call from the troops.

The general unloading period is primarily logistic and quantitative in character. Speed and volume are emphasized, and unloading proceeds without regard to class, type, or priority of cargo. This period does not start until the attack ashore is progressing favorably and beach dumps are organized and troops ashore are prepared to move large amounts of supplies across the beaches. Even after general unloading is in progress, an emergency ashore may make it necessary to cease general unloading to land designated supplies, or even revert to off-loading in accordance with the landing sequence table.

Ordinarily, a few berths as close to the beach as hydrographic and combat conditions permit are designated as general unloading berths and ships are ordered to them in order of priority.

HATCH CREWS

The organization of a hatch crew will vary with the ship, the cargo being handled, and the rig being used. The following is typical.

The hatch captain, usually a BM1 or a BMC, is the person in charge. He or she may act as the signalman, but frequently a hatch tender is added to the crew to perform signalman duties. Normally the hatch tender is next senior to the hatch captain. Both wear distinctive clothing so they are readily spotted by the winchman and whomever else may need them.

The hatch captain is responsible for the way cargo is handled and, therefore, should take the responsibility for training the crew.

Before loading or unloading is accomplished, the hatch captain should become familiar with the plan, for he or she is responsible for (1) rigging the booms; (2) assembling and checking slings, steadying lines, cargo nets, and other equipment that will be needed; (3) seeing that the hold is clear and ready for cargo; (4) after unloading, gathering up the dunning and shoring; (5) off-loading or stacking dunning and shoring and securing them in the hold or on deck; and (6) making certain safe cargo-handling practices are followed.

The signalman (hatch captain or tender) gives signals to the winchman. The signalman must always be in plain sight of the winchman and still have an unobstructed view of the load. A signalman must never lose sight of a moving load and must not give the signal to move that load until certain the load is ready. Slings must be properly attached, steadying lines (when used) bent on, and cargo handlers clear.

The winchman is responsible for (1) calling for power for the winches, (2) checking to see

that the topping lift wires or bull chains are properly secured, (3) checking the winch drums to see that there are no overriding turns, and (4) checking the cargo whips to see they are free to run. The winchman then tests the winches and reports to the hatch captain when ready in all respects to handle cargo.

Cargo being hoisted or lowered should not be allowed to swing. The tendency to swing can be prevented in the hold or on the pier by using steadying lines. Occasionally a draft will start to swing athwartships while being carried across the deck. Such swinging must be kept to a minimum while the draft is in transit and stopped before the draft is landed. For safety reasons, practice in stopping the swing of a draft is best accomplished by operating with an empty pallet. When moving outboard, wait until the draft is at the highest point of its arc swinging outboard, then slack the whip on the hatch boom winch quickly so that the slings supporting the draft assume the usual perpendicular position. A wildly swinging draft often results in damaged cargo and endangers the lives of personnel working in the hold or on the pier.

When training winchmen, have them handle the draft in three distinct movements; hoisting, racking, and lowering. In hoisting, one winch supports the entire load, the other maintains slack. When the draft is clear of the rail, or coaming, it is carried across the deck by both winches. That is called racking. When a draft is in position to be lowered, the second winch supports the entire load. It is the winchman's duty at that time to maintain slack in the whip. It is extremely important that the proper amount of slack be kept in the nonworking whip during hoisting and lowering phases of the draft's cycle. If the whip is kept too tight, the draft will strike against the side of the ship or the coaming of the hatch. If the whip is allowed to make excess slack, loose turns will pile up on the drum of the winch and the wire must be rewound for safe operation.

Every winch has a definite lifting capacity. Most winches in ships will exert a force of from 4 to 7 tons on the whip leading from the drum. It is expressed as the lead line pull and is stamped or marked on every winch, usually on the manufacturer's identifying plate. If the mark is obliterated, the ship's engineering department should be able to supply the information. All winch operators must know the limitations of their machines to prevent overloading, with its resultant dangers to cargo and personnel. (Boom load limitations are marked on the boom itself and are also listed in the ship's specifications.)

On the other hand, it will be up to the hatch captain to determine whether the load exceeds the lifting capacity of the winch and boom. The hatch captain must be able to estimate quite accurately the weight of material and equipment being loaded. Most of the time that will require only simple addition, since the weights of cases and packages are usually plainly marked on the container. To determine the weight of heavy equipment such as trucks, the hatch captain need only consult the loading plan. At times, the hatch captain will have to gather all the necessary information concerning the weight, then make an estimate. Then he or she must check the lead line pull or winch capacity for overloading before ordering the winchman to hoist away.

When handling vehicles and other heavy loads that are prone to swing, there should be two or more steadying lines bent to the load and sufficient personnel to tend them. There also should be an equal number of personnel on the pier or in the landing craft for the same purpose. Another person should act as safety observer on the pier or in the boat. This individual must not be encumbered with other, distracting duties, but can hook and unhook slings on the cargo hook because these tasks are performed when the load is at rest. When using a swinging boom, two or more persons are required to man the guys.

The number of personnel needed in the hold will vary with the type of cargo being handled. Regardless of numbers, the most competent and trustworthy personnel should be given the responsibility for seeing that all safety precautions are observed, and should be given authority commensurate with their responsibility.

OPENING AND CLOSING HATCHES

The hatches of most Navy cargo-type ships are closed by mechanically operated hatch covers. Several types of mechanically operated hatch covers are installed in Navy ships. Made in one or more sections, they are opened or closed either hydraulically by the hydraulic system or mechanically by the cargo whip rove through blocks shackled to the hatches or by special tackle with the hauling part run to a winch. Lugged wheels ride on a track welded to the hatch coaming shelf. Holdback latches secure panels together in the open position. Most hatches are provided with a safety pawl and preventer chains that must be properly secured each time the hatch is opened to prevent accidental dropping/closing of the hatch. Additionally, hydraulically operated hatches are provided with an emergency manual means for opening the hatches in case the hydraulic system fails.

Some mechanical hatch covers are watertight; others are not. Watertight hatch covers are equipped with special neoprene gaskets that, around the outside, seat on a knife edge on the coaming shelf. Gaskets between the panels seat on knife edges of the adjacent panel, forming a watertight seal and a channel for water to run off. When closed, covers are secured by drop dog bolts similar to those on ordinary small hatches.

SAFE CARGO-HANDLING PRACTICES

Cargo handling is full of dangers for careless personnel. It is your job as a petty officer to see that all safety precautions are strictly observed by all hands at all times. The list following contains some commonsense precautions all cargo handlers must observe. Otherwise they will endanger themselves and their shipmates.

1. Wear safe clothing and shoes. Do not wear trousers that are too long, and do not wear rings while at work.

2. Use the accommodation ladder or brow for boarding and leaving the ship.

3. Climb ladders in the hold only when the hoist is not in motion.

4. Use the walkway on the ship's side away from the side on which the hoist is operating.

5. Secure hatch tent lashings to permanent deck fastenings. Never depend upon movable objects lying on deck (such as strongbacks, dunnage, hatch covers, etc.).

6. Lower blocks, crowbars, chain slings, bridles, etc., into the hold by cargo falls or other lines.

7. Stand in the clear away from suspended loads.

8. When steadying loads, do not stand between the load and any fixed object. Always face the load and keep feet and hands in the clear.

9. Stand clear of slings being pulled from under loads by cargo falls.

10. When using a dragline to move cargo, stand out of the bight and clear of the throw of the block and hook.

11. Be especially attentive when handling objects with sharp or rough edges.

12. Keep your hand hook pointed properly and the handle tight.

13. Learn to lift properly to prevent strains and sprains.

14. Always use a light when entering dark places.

15. Never walk backwards.

16. Step down from elevations—never jump down.

17. Bend over projecting nails to prevent puncture wounds.

18. Report to your petty officer in charge any defect in tools, materials, appliances, and gear.

19. When short pieces of dunnage are required, use only the proper cutting tools. All breaking methods are dangerous.

20. Report all injuries (even scratches, cuts, and splinters) to your leading petty officer and get immediate first aid or medical attention.

21. Know the location of fire alarm boxes and firefighting equipment.

22. Do not engage in horseplay, practical jokes, or arguments. They are shortcuts to the hospital.

23. Never enter a compartment which has been secured for a long time until it has been determined that is is safe to do so.

24. Never stand on deck machinery.

25. Never stand in or near the square of the hatch when the hoist is in motion.

26. Do not smoke in holds where there is cargo or dunnage.

In addition to the foregoing safety precautions, the petty officer in charge should—

1. Make frequent inspections of the gear, including standing and running rigging, bridles, guys, shackles, etc. Any unsafe condition should be corrected immediately.

2. Report immediately to a superior any conditions or defective gear which he or she cannot correct.

3. Supervise the raising and lowering of booms.

4. Inspect to see that boom topping lifts, guys, and preventers are secured properly.

5. Check the save-all to see that it is in place when required and is properly made fast.

6. Ensure hatch safety pawls and preventer chains are in place.

7. See that equipment is stowed in a safe, orderly manner and that there is a clear space for a walkway between hatch coaming and ship's side.

8. Make sure that good housekeeping is observed in ship's holds and on decks at all times, and that bridles, blocks, slings, etc., are not permitted to remain where personnel can fall over them or where they may be damaged.

9. See that lines, topping lift pendants, and other pendants are not allowed to remain needlessly on deck where they may be damaged if a strongback or slingload falls on them, or where they may cause personnel to trip or to fall.

10. Make certain that oil, water, and other slipping hazards are cleaned up, sanded, or covered with dunnage.

11. Ensure that adequate hatch lighting is provided.

12. Tell and show personnel how to work safely, and insist that they do so.

13. Instruct personnel in how to break down or build piles or slingloads and break out and stow cargo in a safe manner.

14. See that all slingloads are built safely and slung properly before they are lifted.

15. Show personnel how to lift properly.

16. Never permit personnel to stand or work below suspended slingloads.

17. Know what to do in event of injury.

18. Learn the location of fire axes, hose, and other firefighting equipment, and how to use them.

19. Know how to remove personnel quickly from vessel and pier when necessary.

20. Ensure that personnel do not attach guys, fairlead blocks, and other items to be put under heavy strain to untested pad eyes.

21. Ensure that portable safety stanchions and lifelines are in place at every deck level.

CARGO GEAR SAFETY

Before and after every cargo-handling operation, the BM in charge should inspect the rigging to see that all is in order. Some items, such as cargo whips, should be inspected frequently during operations. The following articles require your attention.

CARGO WHIPS: In addition to the usual inspection given all wire ropes before, during, and after cargo-handling operations, check the eye of the whip and that portion of the wire that constantly reels and unreels on the drum of the winch. Look for signs of wear and broken wires. Check the thimble of the eye for distortion and sharp edges.

BLOCKS: Check sheaves and swivels to see that they are properly lubricated and that they turn easily. Check shackles and shackle pins for distortion. See that mousings and safety shackle pin nuts are secure.

BOOMS: Check all fittings for signs of wear, distortion, and cracks, paying particular attention to the gooseneck. When topping and spotting a boom, make sure that the pin in the gooseneck turns freely.

CAUTION: Never slue a boom while it is topped up high, because the large amount of force necessary to do so tends to bend the gooseneck pin.

GUYS: Inspect the vangs or guys for wear in the eyes, bent thimbles, and broken wires. Inspect the line of the tackles for deterioration, wear, and excessive loading. Check blocks, as already described.

TOPPING LIFTS: In addition to the usual inspection given to wire ropes, make sure that topping lifts with their own winches are long enough to lay the boom head on deck, even if the boom normally rests in a crutch high above deck. If the topping lift is not long enough to permit the boom head to reach the deck, make certain that the end of the wire is securely shackled to the winch drum, so that the boom cannot fall if all the topping lift pays off the winch drum.

CARGO HOOK: Inspect for elongation, distortion, cracks and proper functioning of the safety latch.

CHAPTER 4
CARGO STOWAGE

In chapter 3 we were concerned with planning for loading and stowing cargo. In this chapter our concern is with the actual stowage.

There are five objectives which the Navy strives to attain in the stowing of cargo:

1. Protection of ship and crew from damage or injury.
2. Protection of cargo from damage, spoilage, or other injury.
3. Maximum use of space available.
4. Speed in loading and unloading.
5. Maximum stability of ship. (Equalize weight between the holds to reduce hogging or sagging of the ship.)

To meet these objectives, the Navy has divided the subject of military cargo into the following general classifications:

1. Bulk cargo, such as grain, coal, gasoline, and fuel oil.
2. Dangerous or "label" cargo, such as ammunition, high explosives, chemicals, gases, and flammables.
3. General cargo, consisting of supplies and equipment furnished by supply services.
4. Perishable cargo, requiring ventilation or refrigeration during transit.
5. "Strongroom" or "critical" cargo, such as mail, valuables, drugs, and secret shipments requiring special attention.

METHODS OF STOWAGE

The way cargo is to be stowed depends on the type of load, but there are three general methods of stowage; horizontal, vertical, and block.

In horizontal stowage, cargo is divided into classes, and each class is stowed in horizontal layers or tiers, one on top of the other over the entire area of the hold. Cargo for different ports or cargo of different types may be easily segregated in this manner. For example, as shown in figure 4-1, ordnance stores may comprise the first tier or two; electronic supplies, the next tiers, and engineering parts, the top tiers. This method normally results in better use of space than vertical stowage and offers a better discharge rate for a particular class or type of material. There is, however, little or no selectivity of items or classes.

In vertical stowage (figures 4-1 and 4-2), cargo is divided into classes, and each class is stowed in vertical blocks extending from the square of the hatch outboard and to the forward and after bulkheads. Each class is located to allow access to it from the square of the hatch. This method is emphasized in combat loading, because it provides maximum selectivity.

In block stowage, an assortment of equipment or supplies is made up and stowed in one place. Block stowage permits a balanced portion of the entire cargo to be discharged without disturbing the remainder.

CARGO HOLDS

Cargo holds vary in size and shape, depending on the ship and their locations aboard ship. A typical hold is as deep as the space between decks. It has a small hatch at one or both ends, served by an elevator operating in a trunk. In the hold, forklift trucks bring cargo to the elevator and, on the main deck, other forklifts deliver the cargo to replenishment stations. Perforated channels run

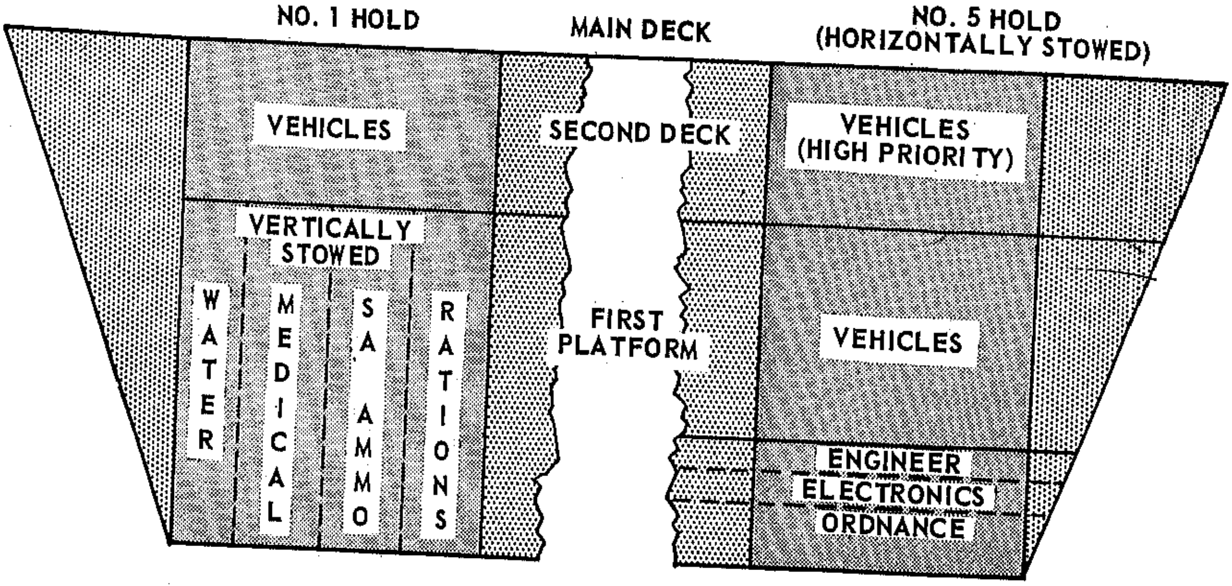


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Figure 4-1.—Methods of stowage (profile view).

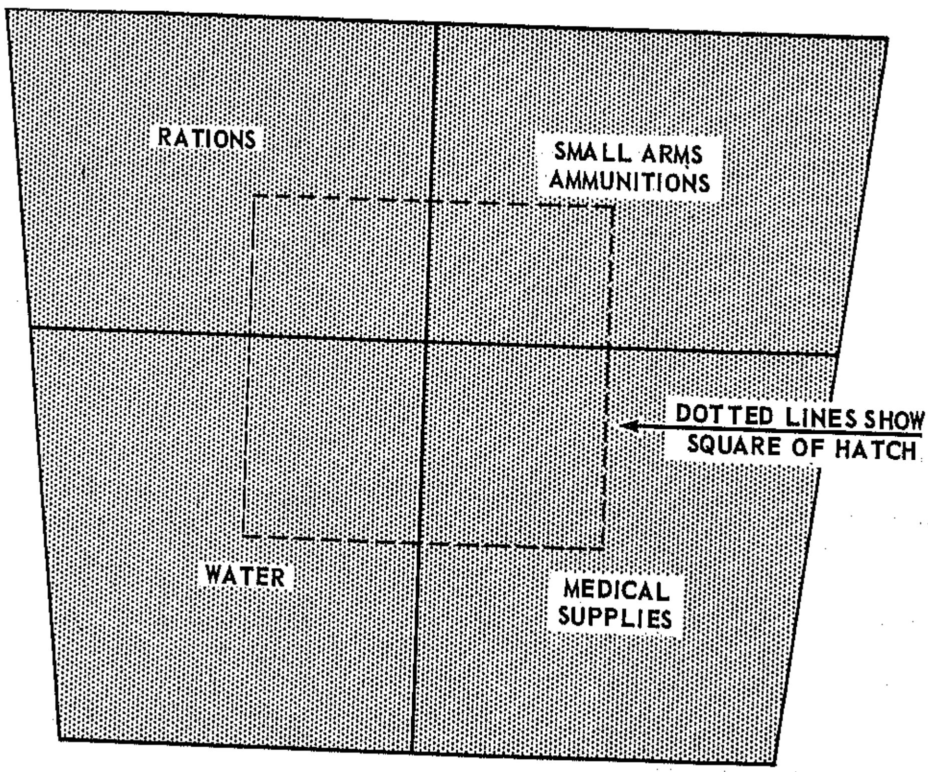

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Figure 4-2.—Vertical stowage (top view).

diagonally across the deck and overhead of the hold. These channels hold metal dunnage, explained later.

The condition of the holds is very important and, before cargo is loaded, the holds must be checked to see that they are clean and dry. Drains must be operative. Reach rods leading to the drain check valves in the lower hold should be checked to see that they are not broken and that they turn freely. Look for streaks of rust or oil that indicate leaks in pipes, sides, and bulkheads. Pay particular attention to pipe flanges. Check the knife edges and gaskets on side ports, and examine the closures for ventilation ducts.

Sweat battens, wooden sheathing secured to transverse bulkheads, and wooden casings around pipes and conduits should be inspected and replaced if necessary. Frequently, the replacement can be done when cargo is being unloaded, as the cargo then provides a solid platform on which to stand. Ladders are occasional casualties of cargo-handling operations and, therefore, should be examined with care and repaired promptly. Inlets to the smoke detecting system must be clear.

STOWAGE IN HOLDS

Before you begin to stow cargo it usually is a good idea, and frequently necessary, to lay a floor of two or more layers of dunnage. The boards in the first layer may be placed up to 12 inches apart, and they must lie in a direction that will allow moisture to flow toward the drains. The second layer is laid at right angles to the first and, if there is a third layer, it will be at right angles to the second. The top layer may be solid, or the boards in it may be several inches apart, depending on the cargo and its container.

CARTONS AND CASES

For cardboard cartons, the spacing of the top layer of dunnage may be up to 4 inches. When stowing, either start at the centerline and work outboard in both directions, or start at one side and work toward the other. Each tier must be kept perfectly level. For example, in some ships the deck of the lower hold may rise a little in the wings as the deck approaches the turn of the bilge. Boxes should not be stowed on this rise as succeeding tiers above will put extra pressure on the tilted edge of the wing boxes and crush them. The space should be filled in with dunnage, and dunnage should be placed vertically against the sweat battens to prevent cartons from becoming hung on the battens as the ship works (figure 4-3).

On the third tier lay a floor of dunnage, and on the sixth tier lay another floor. After that, it only is necessary to lay a floor on every sixth tier. No more than four floors will be needed. By taking part of the strain, these floors prevent a chain reaction of sagging, crushing, and breaking in case a bottle should break or a can should be crushed in one of the bottom tiers.

Succeeding tiers are laid in brick fashion; that is, each carton rests on two beneath it as shown in figure 4-3.

Like cartons, cases (tight wooden boxes) may be stowed brick fashion but, because they are stronger, they do not need the dunnage floors between tiers. When you are vertical loading, however, dunnage may be used to give greater stability to the stack. Cases also may be stowed block fashion (figure 4-4) or, depending on contents, stood on their ends or edges.

With both cartons and cases, when the length is twice as great as the width, the boxes in the first tier might be placed with the long dimension running fore and aft, those in the second tier with the long dimension running athwartships, those in the third tier like those in the first, and so on. The same effect can be obtained by altering the directions of the boxes in the two rows at the edges of a stack as shown in figure 4-5.

CRATES

Crates are framework containers, sometimes with open sides and ends and sometimes with sides and ends enclosed by cardboard or thin plywood. Crates for ocean shipment should be strengthened with diagonal braces, and those not so strengthened must receive special care in stowage. The best place to stow crates is in 'tween deck spaces or in the top tiers of the lower hold. Only light cargo should be stowed on top of crates. Dunnage must be placed between every tier of crates. Crates, therefore, need not be stowed brick fashion.

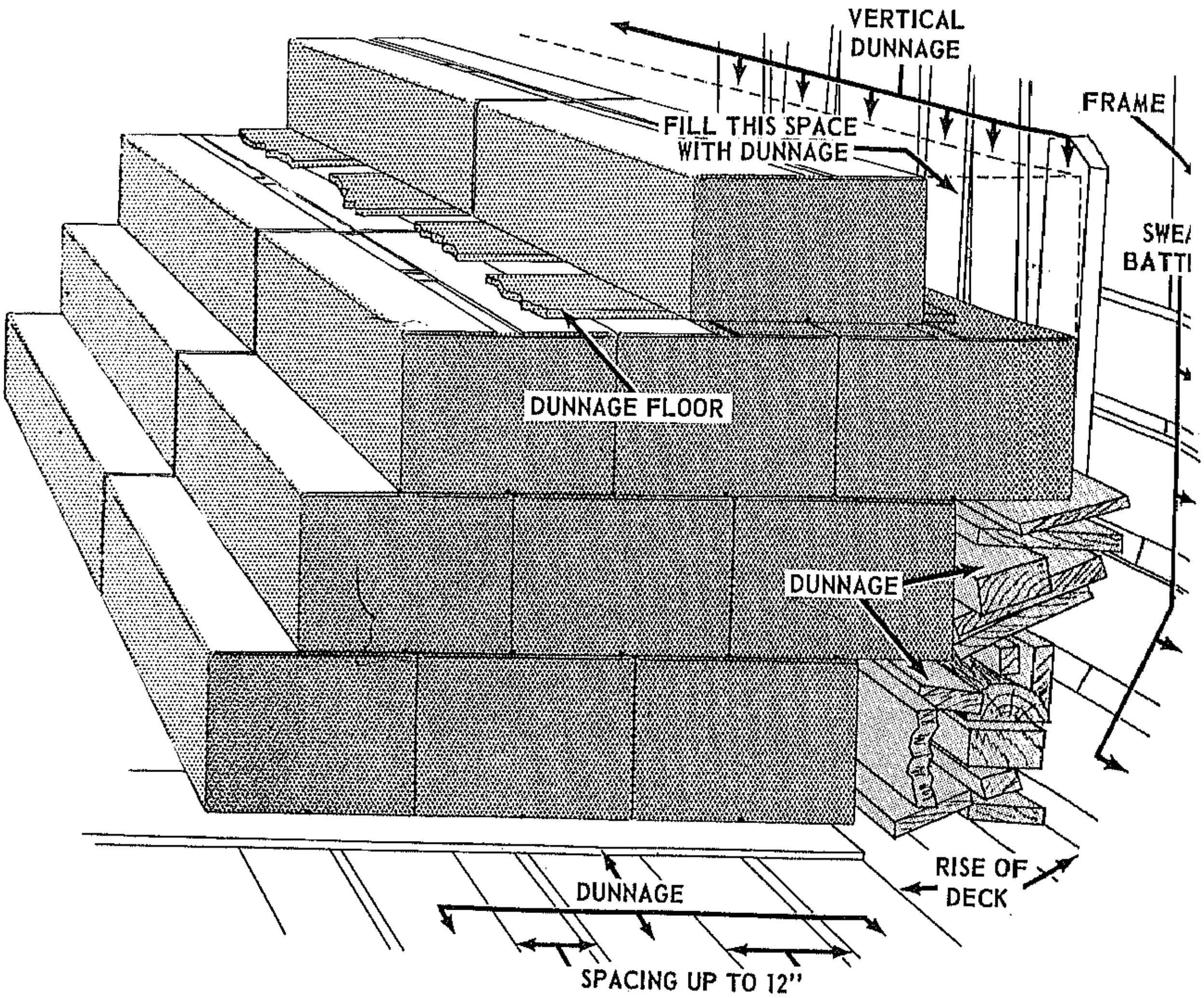

Figure 4-3.—Brick stacking cardboard cartons. 58.29

DRUMS

Drums may be deck loaded or placed in the hold. If struck below, a single layer of dunnage should be laid down to provide drainage and friction against rolling.

Drums are stowed on end, with bungs up and packed together as closely as possible. If a row of drums does not completely fill the athwartship space, the drums should be spread evenly, and those in the second row set in the intervals between. That eliminates the necessity for additional bracing or dunnaging to fill the extra space at the end of the row and may make room for more rows in the hold. However, dunnage must be stacked between the outboard drums and the flare of the sides.

To spread the weight and prevent bending the chines, two strips of dunnage should be laid over every row in each tier.

BAGS

Before loading bags, spread a dunnage floor of two or more layers to keep the bags off the steel

58.30
Figure 4-4.—Block stowage of small boxes.

deck and provide drainage. If ventilation is not a problem, the top layer may be solid. In any event, the spacing of the top layer should not be more than 1 inch; otherwise, the weight of the top tiers will cause the bags in the bottom tier to split. Vertical dunnage must be used to keep the bags from the sweat battens and from steel stanchions, bulkheads, ladders, and so on. Normally, no other dunnage will be needed.

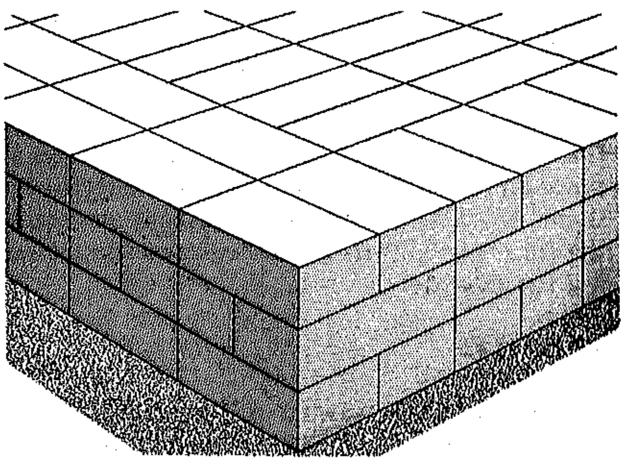

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Figure 4-5.—Alternating directions of boxes in edge rows.

Bags may be stowed in any of the ways shown in figure 4-6. Alternating them as in view A or using strips of dunnage as in view C makes a secure stack, but piling the bags as in view D makes better use of the space. The method of stacking shown in view B provides fair ventilation, but some commodities, such as rice and onions, require circulation of air throughout the cargo. This circulation can be obtained by using venetian vents (figure 4-7).

Venetian vents are erected vertically at the four corners of the hatch and below the cargo hold ventilators. Others are laid fore and aft and athwartships from the vertical vents to form a system which allows air to circulate through them. Vents laid athwartships should extend from side to side so that the spaces between the sweat battens and the ship's sides become a part of the system. The numbers of vents required depend on the cargo, but in any case they need not be closer together than every 5 feet.

REELS

Many reels containing sheathed cable have special handling instructions stenciled on their sides. These instructions must be complied with lest careless handling ruin the cable.

Generally, large, heavy reels should be stowed in the lower hold with their axles athwartships. They should be chocked with 8 x 8 timbers cleated together by 2 x 6s and lashed and shored as securely as possible. Preferably, the reels should be blocked in by other cargo such as rags, lumber, or other items that can stand a little chafing. Otherwise, dunnage bulkheads should be constructed about 6 inches from the reels to protect adjacent cargo from them.

Small reels may be tipped on their sides and, depending on their contents, braced and dunnaged if necessary.

IRREGULAR-SIZED CARGO

Regardless of the cargo, the way it is packaged, or the type of load, it should be stowed, if possible, in such a way as to keep the tiers level. When stowing boxes and crates of uniform size, this is no problem. Frequently however, there are

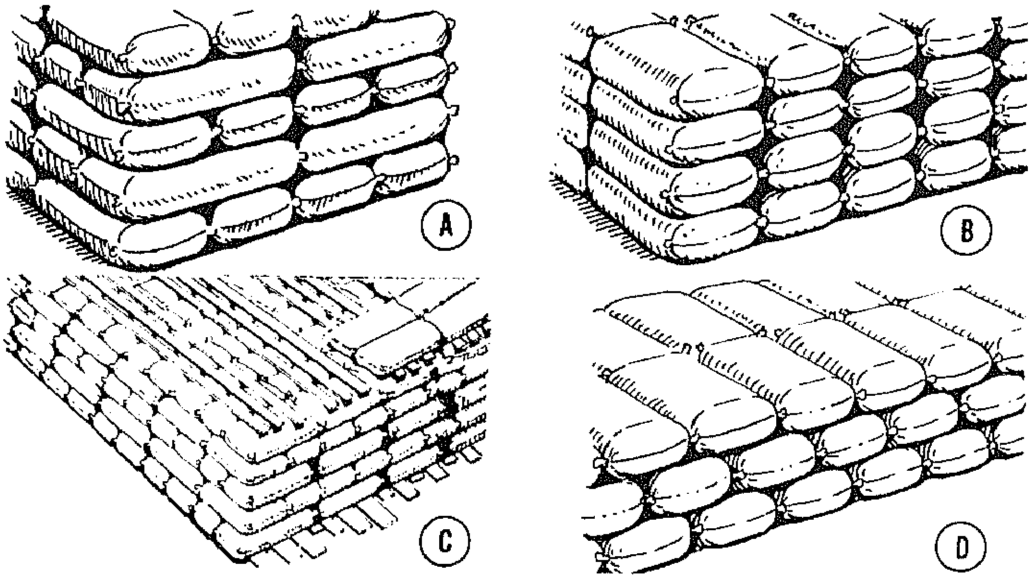
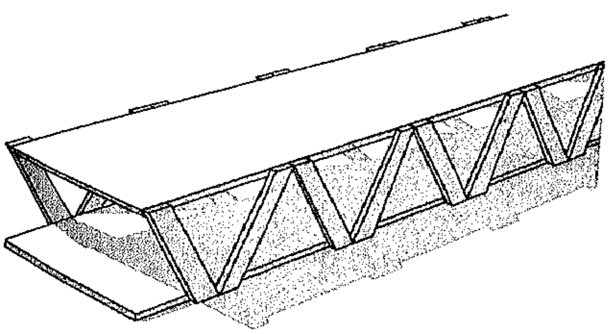


Figure 4-6.—Stacking bagged goods.

odd-sized packages to be stowed. In such instances, outsized items can be located in the most advantageous positions and the numerous boxes of uniform size stacked around the larger ones. Undersized boxes and dunnage can be used to fill in small spaces that otherwise would be left void. Layers of dunnage should be used as necessary to build a level floor for succeeding tiers.



58.34
Figure 4-7.—Venetian vent is used to promote circulation of air through bagged goods.

UNIT OR PALLETIZED LOADS

A great deal of the cargo carried in Navy ships is strapped on pallets or otherwise banded together to form loads of uniform size. An example of unit loads not strapped on pallets is lumber, which is made up in package units 2 feet high, 4 feet wide and 8 to 16 feet long.

Such cargo is moved from the square of the hatch to its stowage position by forklift trucks. A normal procedure is to stack unit loads two or more high throughout the hold and then fill in the area under the hatch. The slings are left in place on the last few loads to facilitate removing them. A solid floor of dunnage is laid on the top tier for the forklift truck to operate on while stowing the next tiers.

VEHICLES

Vehicles pose stowage problems peculiar to themselves because of their size and mobility. It is not difficult to picture the havoc an unsecured heavy tank could wreak during a heavy sea. Therefore, it is extremely important that you give close attention to the job your crew is doing when

they are stowing vehicles. Great care must be taken to avoid blocking off bitts, chocks, sounding tubes, valves, and other equipment which must be accessible. Spaces to be left clear should be outlined in chalk.

Whenever possible, a wheeled vehicle should be rolled into place with a person steering. If that is not feasible, a rolling car jack may be used to cut either end around, or winch power can be used to pull it into place, the wheels being placed on a dolly. Vehicles should be stowed in a fore-and-aft position with 4 to 6 inches between them to prevent their rubbing against each other. Wheels should be chocked on all four sides to prevent movement in any direction. Individual chocks should then be braced. At times it may be necessary to lash the vehicle with wire rope and put blocks under the frame to prevent sidesway.

Vehicle stowage aboard amphibious ships is somewhat different. Since these vessels are more concerned with vehicle transportation, they are outfitted to handle such equipment as efficiently as possible. For example, they have a number of vehicle lashing sockets in their holds and on deck. These sockets are so situated that vehicles, including tanks, may be run aboard and stowed between them. Gripes are then secured to the sockets and to the vehicle. A turnbuckle in the center of the gripe is used to take up the slack and secure the vehicle firmly. The recommended minimum number of lashings required for wheeled or tracked cargo is four, two crossed forward and two crossed aft like spring mooring lines to prevent sidesway of the vehicle. Heretofore, gripes of this type were made of chain, but there now is available a cable-type lashing with an improved lightweight quick-release hook. (See figure 4-8.) This cable is used primarily for securing vehicles, but similar cables are incorporated into nets and used to secure cargo on deck and in the holds. If such gear is unavailable, wire rope and turnbuckles or Spanish windlasses can be used to prevent sidesway. Never use fiber line for this operation. Wheels are chocked, but chocks are not braced as they are when the vehicle is not secured by gripes. Thus, through the use of

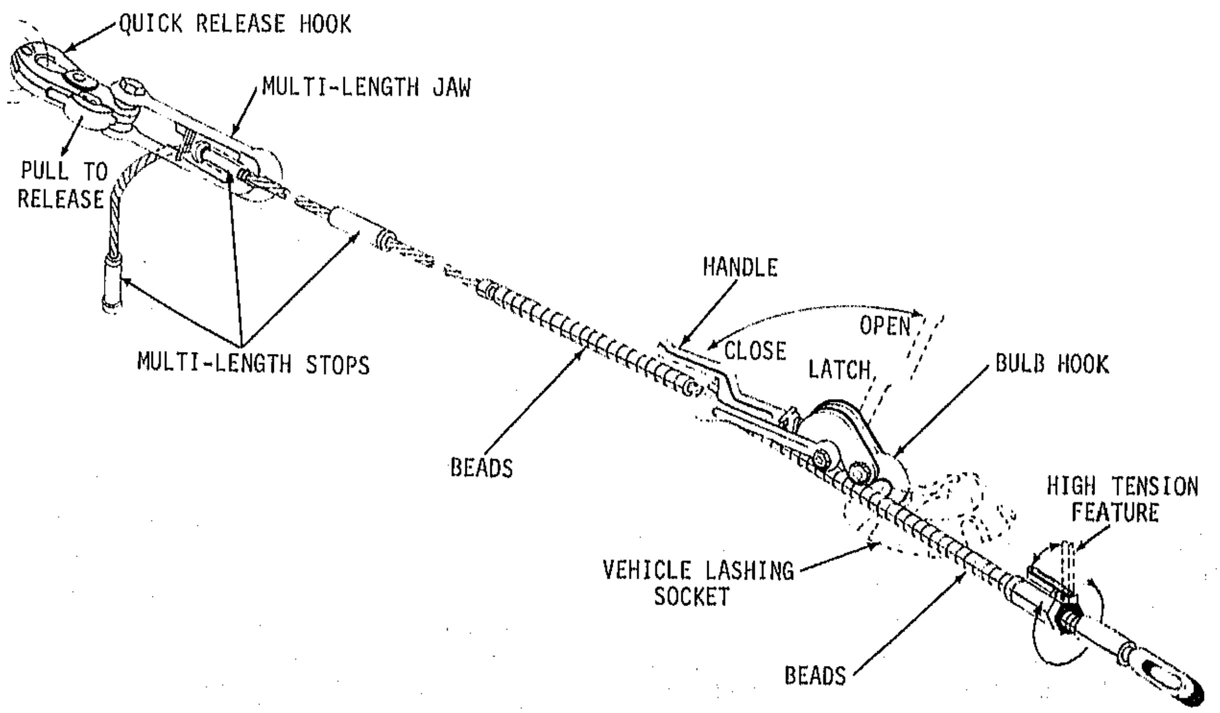


Figure 4-8.—Peck and Hale adjustable cable.

vehicle lashing sockets, a small working party can secure in short order a number of vehicles which would present a major problem aboard a ship not so equipped.

Vehicle lashing sockets eliminate the elaborate bracing and use of dunnage necessary when vehicle lashing sockets are not available. Dunnage is used, however, when the gripes are secured over a tank to vehicle lashing sockets on either side. In such cases, dunnage is placed under the gripes at those points where they come into contact with the tank. This eliminates chafing, which could result in the gripe's parting during particularly heavy weather.

Before leaving the subject of vehicle stowage, one more point is worth mentioning: Normally, vehicles to be stowed belowdeck should have all fuel removed from their tanks and any lingering fumes removed by ventilator. One of the cables should be removed from the battery, and the vehicle should be grounded to bleed off any static electricity charges. (Ordinarily, the gripes will serve as grounds.)

There is one exception to the rule about draining fuel tanks. The tanks of vehicles which are to take part in an amphibious operation are filled to 75 percent capacity, and a reserve supply of fuel and lubricants in 5-gallon cans is secured to the vehicle. The space left in the tanks allows for expansion of the fuel.

DECK CARGO

Deck cargo consists of miscellaneous gear for which there is no room below, or which, because of its nature or size, cannot be stowed belowdeck.

Because of the varying sizes and shapes of commodities stowed on deck, few specific rules for their stowage can be given. This section will, however, present material which applies generally to the stowage of all deck cargo.

When stowing a large quantity of cargo on deck, take care to avoid blocking off bitts and chocks, sounding pipes to the bilges and ballast tanks, handles of valves controlling the opening of watertight bulkheads or piping systems, or other equipment essential to the operation or safety of the vessel. You might find it helpful to mark off, with chalk, spaces to be kept clear.

Any deck load, being high above the center of gravity of the ship, affects the ship's stability by reducing the value of the righting moment–ability of the ship to return to an even keel after a roll. There will be times, however, when safe deckload heights cannot be met. For example when hauling small boats, landing barges, unboxed aircraft, and certain cased aircraft, the deckload will often exceed the safe deckload height of the ship hauling the cargo. In no instance, however, should cargo be stowed above 12 feet where stowage requires more than one tier.

When loading on deck, catwalks should be constructed for the crew. Such walks should be not less than 3 feet wide and should be provided with handrails. Where possible, ramps should be built to the main deck so the crew will have ready access to lifeboats, gun stations, and other installations.

Deck cargo should be stowed so that it can be lashed in three separate blocks, one on the square of the hatch and one on each side. If the nature of the deckload so warrants, use additional overall lashings. Wire, chain, rods, or straps may be used for lashings. Mechanical purchases with ratchet-type handles or turnbuckles should be fitted in each lashing to permit further tightening, irrespective of the type of lashing used. Hook turnbuckles are not used, however. When using wire or chain for lashing, make round turns on each end of each block of cases. Other lashing can be overall. For example, with cases 36 feet long on the square of the hatch, round turns should be used on each end of the case. If two cases, each 15 feet long, are stowed in the square of the hatch, round turns should be used on each end of each case, making four round-turn lashings on the square of the hatch.

Edges of the cases underneath the lashings are protected by wooden capping made of lumber not less than 2 x 6 inches. The capping extends the entire length of the case in one solid piece from end to end. Dunnage must never be used for this capping. In addition, angle irons 6″ x 3/16″ x 18″ are used under each lashing. The left inset in figure 4-9 is an angle iron.

Sometimes it is necessary to strengthen the outboard sides of all cases stowed on deck by running 2-inch planking vertically on each case. This

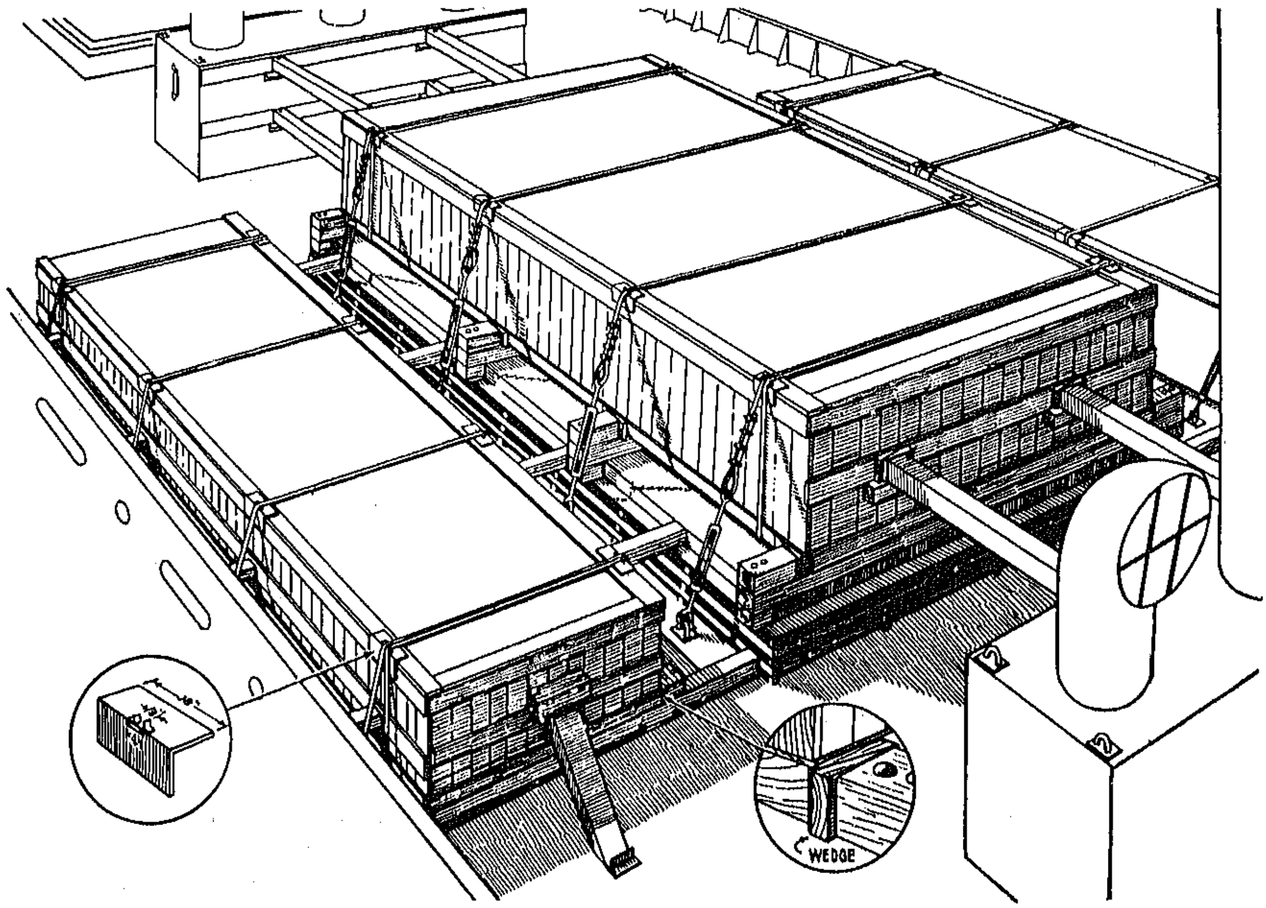


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Figure 4-9.—Stowage of deck cargo.

planking should cover the entire side of the case, be nailed to the top and bottom of the case, and be secured by battens.

Planking serves to make an entire new side of the case, strengthens it, and helps prevent the sides of the case from being smashed should the ship run into heavy seas. Exposed forward parts of the cases should also be sheathed in the same manner. Sheathing is necessary because cases in general are relatively weak.

By examining figure 4-9, you can get a good idea of how cargo is secured on deck. The angle iron under the lashing prevents wire rope or chain from cutting through the edges of the case. Round turns on ends of cases can be drawn tight by taking a bight of the lashing (where it comes up from under the case) and placing a Blackwall hitch on the cargo hook, then "take up." The wedges, shown in insert of figure 4-9, will take up any slack in braces. Wedges should be nailed in place after tightening.

Turnbuckles have space left for further tightening en route. Wire clips have their roddles against the standing part of the rope with the U-bolt section against the bitter end. The rule for number and spacing of clips is: For number of clips, 3 times the diameter of the wire being used plus 1; for spacing, 6 times the diameter. For example, 1-inch diameter wire rope used for lashing would require 4 clips spaced 6 inches apart.

When tanks are stowed on deck, they are landed with the treads placed on 2 pieces of

4 x 12 lumber 20 feet long. On each side of each tank a piece of 8 x 12 lumber 20 feet long is placed against the sides of the treads, the 8-inch side to the deck. These are secured by 3 angle irons 6 x 8 x 15 inches of 5/8-inch stock, the 6-inch side welded to the deck. Each angle has 2 holes in the 8-inch side for 7/8-inch lag screws for securing the 8 x 12 fore-and-aft timbers.

Each end of the tank should be chocked with a piece of lumber 8 x 12 inches placed athwartships hard against the tread and extending between the fore-and-aft timbers at the sides of the tank. This piece is spiked to the 8 x 12 fore-and-aft pieces, and chocked with a piece of lumber 4 x 6 x 12 inches, secured by a lag screw to the 4 x 12 piece under the tread of the tank.

The tank is lashed with four 1-1/4-inch diameter shaft turnbuckles secured to the tank's lifting eyes. Lashings can be either crossed or led outboard of the sides of the tanks to obtain the best possible lead. Hook turnbuckles should not be used. Turnbuckles should be given sufficient thread to permit further tightening. Figure 4-10 shows a tank stowed on deck.

DANGEROUS CARGO

The handling and stowage of dangerous cargo is governed as specified in the *Code of Federal Regulations* (CFR) Title 46—Shipping, parts 146

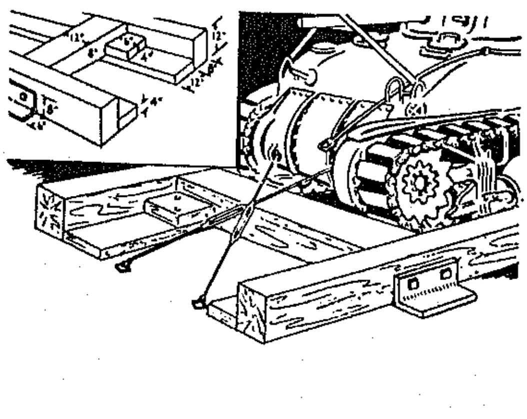

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Figure 4-10.—Securing a tank on deck.

to 149. Those of you who are actively engaged in handling dangerous cargo should become familiar with that publication. For the rest, the general information contained in this chapter should suffice.

Items considered dangerous are—

1. Explosives.
2. Flammable liquids.
3. Flammable solids and oxidizing materials.
4. Corrosive liquids.
5. Compressed gases.
6. Poisons.
7. Combustible liquids.
8. Hazardous articles.
9. Ships stores and supplies of a dangerous nature.

In this chapter, our concern is with explosives, flammable and combustible liquids, and compressed gases.

FLAMMABLE AND COMBUSTIBLE LIQUIDS

Flammable liquids are defined as those liquids giving off vapors with flash points below 100°F. Vapors of combustible liquids have flash points between 80° and 150°F. Handling and stowage requirements are almost identical; hence, to simplify this discussion, only the first term, "flammable", will be used.

Aboard ship, flammable liquids may be stowed on deck, between decks in readily accessible places, or underdeck away from heat, depending upon the type of container. Places of stowage of the various kinds of flammable liquids, as well as other dangerous cargo, are listed in appropriate tables in the *Code of Federal Regulations*.

Stowage of flammable liquids on deck must be accomplished so as to provide safe access to the crew's quarters and to all parts of the deck required in the operation of the vessel. For example, the flammables should not be stowed within 25 feet of a lifeboat nor near fireplugs or sounding pipes. Firehoses attached to fireplugs in the vicinity must be fitted with all-purpose nozzles, and during cargo handling operations, one hose that will cover the area must be laid out and charged.

The CFR calls for two hand portable fire extinguishers of the dry chemical type of at least 15-pound capacity, or two portable 2 1/2-gallon foam-type extinguishers, in addition to the charged firehose. Because the Navy does not use portable foam extinguishers aboard ship, however, this requirement can only be complied with by rigging a proportioner.

Stowage of flammables belowdeck should be in ventilated holds, or in storerooms especially designed for flammables. Holds fitted with electrical circuits having outlets within the compartment should have such circuits disconnected from all sources of power supply unless the fixtures are of a vaporproof type. After stowage of flammables has begun in a compartment not fitted with vaporproof type of electrical outlet, no portable means of artificial lighting may be used unless such portable equipment is of the vaporproof type. Hand flashlights must be of the nonsparking type.

CORROSIVE LIQUIDS

Corrosive liquids are defined as those acids, alkaline caustic liquids, and other liquids which can, by chemical action (1) cause severe damage to living tissue, (2) materially damage or destroy other freight, or (3) cause fire when in contact with organic matter or certain chemicals.

Corrosive liquids must be stowed well away from living quarters, foodstuffs, or cargo of an organic nature, in such a manner that the containers may be readily observed. They must not be stowed over any combustible substance.

Glass carboys containing corrosive liquids may not be stowed more than two tiers high, unless completely boxed or crated in material sufficiently strong to permit stacking.

On-deck stowage must be such that leakage will drain away from other cargo and into a nearby scupper or freeing port. Such drainage cannot be permitted to enter an enclosed drainage system. (Any leakage must be washed off with liberal quantities of water.) If such stowage cannot be arranged, clean, hard, dry sand must be placed under and around the lower tier to absorb any leakage.

Corrosive liquids must not be stowed in the following areas:

1. Underdeck in a ship carrying class A or B explosives, unless one complete hold or the engine and fireroom spaces intervene.
2. On deck in a ship carrying class A or B explosives, unless the bridge structure or engine and fireroom spaces intervene.
3. In the same hold with class C explosives, flammable liquids or solids, or oxidizing materials.
4. Adjacent to or over cylinders of compressed gases or containers of poisonous or hazardous articles.
5. In a hold or compartment over one in which cotton is stowed, unless the deck is tight and of steel and the hatch is fitted with a tight coaming.
6. Over the square of the hatch.

GAS CYLINDERS

Gas cylinders are stowed on deck, 'tween decks, or underdeck.

Cylinders may be stowed on their sides, in a fore-and-aft position, with each succeeding tier placed in the cantlines of the tier below (figure 4-11). At no time may they be stowed bilge to bilge. Two layers of dunnage must be used to keep the cylinders from coming in contact with deck, bulkheads, sides, or bulwarks. Alternate tiers may be stepped back and ends reversed to clear the flanges. Cylinders must be adequately lashed or

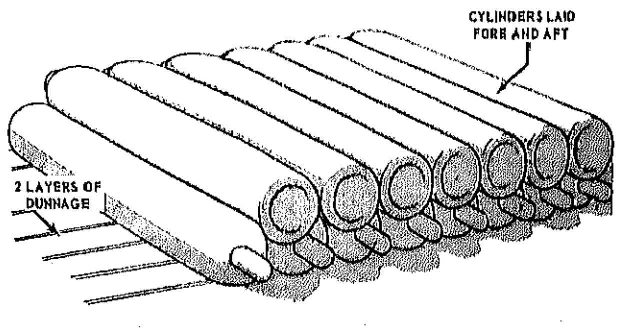

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Figure 4-11.—Stowing gas cylinders.

shored and tommed to prevent movement in any direction.

At times it is more convenient to stow cylinders standing on end. In such instances, sturdy boxes, cribs, or racks for them must be built of 2-inch lumber, and the cylinders must be at least 4 inches off the steel deck. They must be securely lashed with wire rope and turnbuckles or secured with steel strappings.

If stowed on deck, gas bottles must be protected from the direct rays of the sun by awnings or some structure providing shade. Tarpaulins laid directly on the cylinders will not be satisfactory, but dunnage so laid will suffice.

Cylinders containing flammable compressed gases may not be stowed (unless specially designed storerooms are provided) under the following conditions:

1. On deck within 25 feet of other dangerous cargo.
2. On deck in a ship carrying class A or B explosives unless the bridge structure or engine and fireroom spaces intervene.
3. On deck immediately over a hold or compartment containing class C explosives or flammable liquids in excess of 1 ton.

Cylinders containing nonflammable gases may not be (1) stowed in the same hold or compartment with class A or B explosives, (2) stowed under or adjacent to containers of corrosive liquids, or (3) overstowed by containers of flammable liquids or solids, oxidizing materials, or poisonous or hazardous articles.

MILITARY EXPLOSIVES

Explosives, in general, are divided into three classes, A, B, and C. Class A explosives are those that can be caused to deflagrate by contact with sparks or flame. Examples are black powder, commercial dynamite, fulminate of mercury, nitroglycerin, blasting caps, and detonating primers and fuses.

Class B explosives function by rapid combustion rather than detonation. They include flash powders, some pyrotechnic signal devices, some rocket propellants, and smokeless powder.

Class C explosives are manufactured articles of certain types that contain class A and/or B explosives in restricted quantities and some types of fireworks. Examples are smoke pots; marine illumination signal cartridges; jet engine starter cartridges; hand signal devices; percussion, time, and tracer fuses; and highway fuses.

Military explosives, of course, include all three classes, but for military purposes they are regrouped into ammunition and explosives in bulk. Ammunition is "made up" explosive devices (projectiles, cartridges, grenades, bombs, torpedoes, propellant powder charges, pyrotechnics, rockets, special weapons) used by the Armed Forces in the prosecution of war.

Loosely defined, "bulk" pertains to substances loaded and carried on board without benefit of containers or wrappers. When used to describe explosives, however, the term means that the explosive is not "made up" or packaged for a specific purpose. An example is black powder carried on board to be used in saluting charges.

AMMUNITION AS CARGO

Aboard ships that ordinarily carry ammunition as cargo, the ammunition is not shored or tommed like other cargo. Instead, one of two systems is installed to expedite stowing and securing and off-loading the ammunition. The systems are metal dunnage and wire net shoring.

Metal Dunnage System

The metal dunnage system consists of portable metal stanchions or battens that fit into sockets overhead and in plates inserted in channels welded to the deck. (See figure 4-12.) Hinged latches lock battens in their sockets. An end view of the battens resembles two I-beams welded together. They can be set with either the long or the short dimension to the cargo, making a difference in space of about 3 inches.

The metal dunnage system can be used with both palletized and loose cargo. With loose cargo (powder cans, for example), pen boards are slipped between the battens to form pens or bins in which cargo is placed.

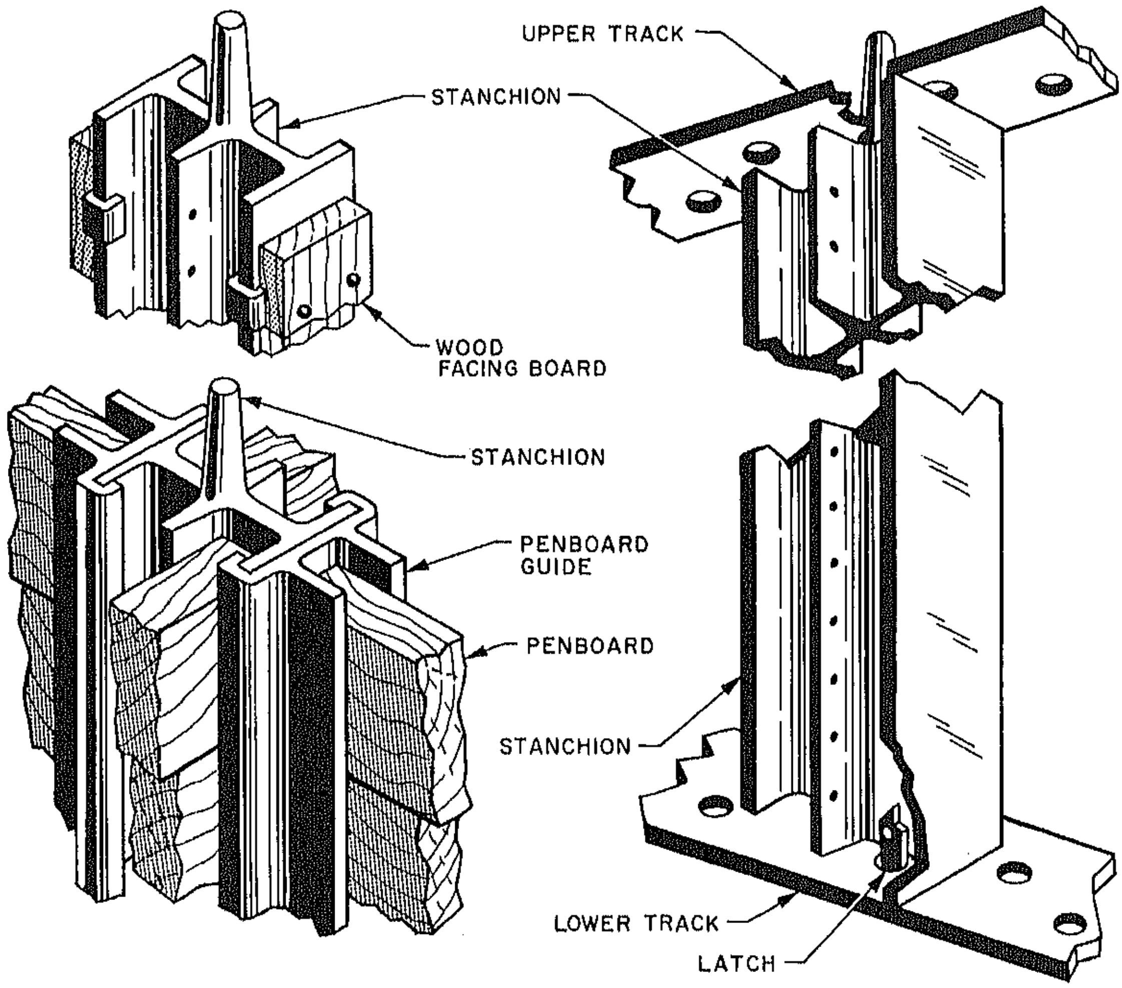

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Figure 4-12.—Metal dunnage and pen boards.

Tomming is done by means of cotton web straps of three types. The extension strap assembly is a long strap with a V-ring at one end and a hook at the other. Other V-rings also are secured to two short tabs sewn at points equidistant from each end and from each other. The spreader strap assembly is a short strap with a hook at either end and a V-ring in the middle. The adjustment strap assembly has a hook at each end. In the middle is a device for shortening the strap. In this system, a combination of straps making up the proper length is laid over the cargo, and each end is hooked in the deck channels or to the battens. The cargo is tommed by setting up on the adjustment strap. Figure 4-13 shows a typical tomming down arrangement with metal dunnage and pen boards.

Wire Net Shoring System

The wire net shoring system consists of wire nets and ratchet tensioning devices for securing them. Nets are about 6 feet wide and long enough to reach from the overhead to the deck. They hook into holes spaced a few inches apart in angle irons welded athwartships every 2 feet on the overhead. Thus, the nets hang fore and aft, providing support for cargo against the roll of the ship. Numerous holes in the angle irons permit

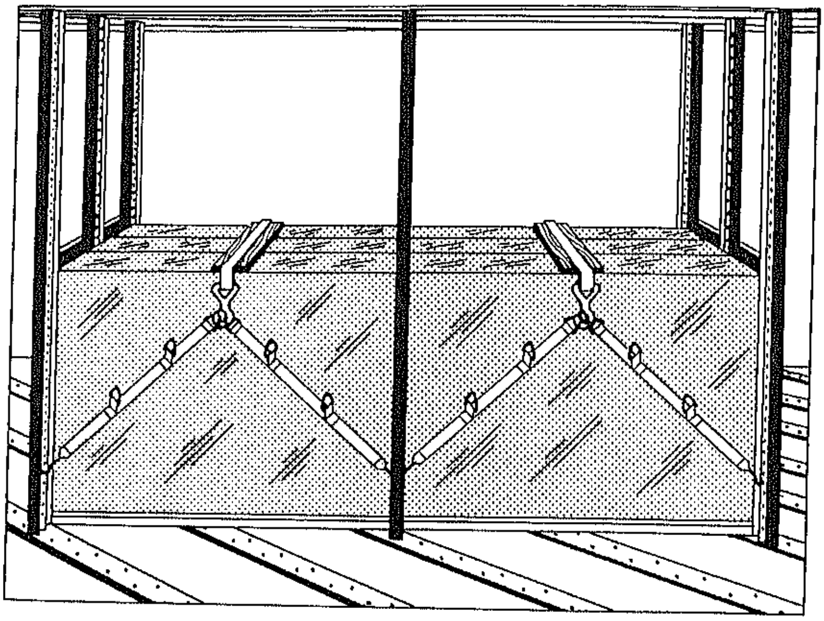

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Figure 4-13.—Typical tomming down arrangement with metal dunnage and pen boards.

nets to be moved inboard or outboard and brought as close as possible to the vertical face of the cargo.

The ratchet tensioning device resembles an automobile jack. One end of the gear rack is fitted with a hook that is inserted into holes in the deck plates. A claw-type hook on the ratchet body engages lugs or beads on the net. When the handle is operated, the ratchet is jacked down the gear rack, drawing the net taut. Three tensioning devices are provided with each net.

In the wire net shoring system, as in the metal dunnage shoring system, wood dunnage is added as necessary to fill void spaces, to provide extra support, and for flooring.

SAFETY PRECAUTIONS

The following safety precautions concerning handling and stowing dangerous cargo supplement precautions printed in other NAVEDTRA and NAVSEA publications.

Precautions differ slightly for different cargo. For simplicity in such instances, we list the more severe requirement.

Lights and Fires

No artificial lights except explosion-proof electric lights, floodlights, or portable lights may be used while loading or unloading flammables and explosives. Bulbs and globes must be protected by stout metal guards against accidental breakage. Insulation of all cables and wires must be sound.

Circuits with other then explosion-proof outlets, lights, or other electric apparatus must be deenergized before starting to handle cargo. They may not be reenergized until compartments or holds have been freed of flammable vapors. Controls of such circuits must be outside the space where dangerous cargo is being handled. Switches must be tagged to preclude anyone's inadvertently energizing the circuits.

Portable lights must not hang from their cords and must be installed in a manner that will prevent any part of a light or cord from contacting deck or cargo. Electrical connections must be outside the compartment or hold and above the weather deck.

Flashlights must be the nonsparking type.

Unnecessary fires must not be permitted on piers, lighters, or ships. Fires deemed necessary by the captain of the port must be safeguarded properly and must be constantly in charge of a competent person.

Two charged firehoses must be laid out while handling flammables and explosives. These hoses must be long enough for one or the other to reach any place in the area. Such hoses must be rigged before the hatch is opened.

Smoking is prohibited in the vicinity of flammable and explosive cargo and near ventilators to holds wherein flammable liquids are stowed. Signs carrying the legend

FLAMMABLE VAPORS,
KEEP LIGHTS AND FIRE AWAY.
NO SMOKING

must be posted at each avenue of approach to liquid flammable stowage and near ventilators to such stowage.

Preparations and Equipment

Before beginning to load dangerous cargo, you must free magazines, holds, decks, gangways, and hatches of debris that creates fire or personnel hazards. Bilges, overhead beams, and strongbacks should be examined and any residue of previous cargo removed.

Equipment that is not being used should be placed on the side opposite to where cargo is being worked. The hatch captain or Master-at-Arms should direct personnel moving fore and aft during cargo operations to use the side deck opposite the side being worked.

The captain of the port is authorized to specify equipment and methods that may be used in handling dangerous cargo. Usually permitted equipment includes—

1. Cargo net with pieplate or other base.
2. Skip boxes or trays.
3. Pallets.
4. Wooden chutes with landing mattress or thrum mat.
5. Hand trucks.
6. Roller conveyors.
7. Mechanical hoists.
8. Approved forklift trucks.
9. Safety hooks.

Equipment that normally is not permitted includes—

1. Hoists or trucks powered by internal combustion engines.
2. Metal bale hooks.
3. Combination fiber and wire rope slings.
4. Slings formed by open hooks.
5. Open hooks (unless moused by wire).
6. Barrel slings.

Wire rope and wire rope assemblies (including splices or fittings) must be kept bare to permit ready inspection. Mechanical type end fittings may be used in lieu of hand splices, provided such fittings have a minimum breaking strength equal to the catalog strength of the wire rope used.

All equipment must be maintained in a safe condition. Before beginning work, a responsible person must inspect all spaces and equipment. Unsafe gear must be replaced and unsafe conditions corrected.

Handling Practices

Persons handling dangerous cargo must not carry firearms, matches, lighters, knives, bale hooks, or metallic tools (except those authorized by the captain of the port). They may not wear shoes or boots shod or strengthened with iron nails or other spark-producing metal, unless they are covered with rubber, leather, or other nonsparking material.

Dangerous cargo must not be worked at the same hatch from both sides of the ship simultaneously, unless the hatch is equipped with two sets of cargo booms. Dangerous cargo must not be worked at the same hatch nor in the same hold at the same time as other cargo.

Cargo drafts may not be handled over explosives or other dangerous articles stowed on deck. Deck-stowed cargo, over which military explosives are passed, must be limited in height to that of the hatch coaming, bulwark, or 3 feet, whichever is greatest.

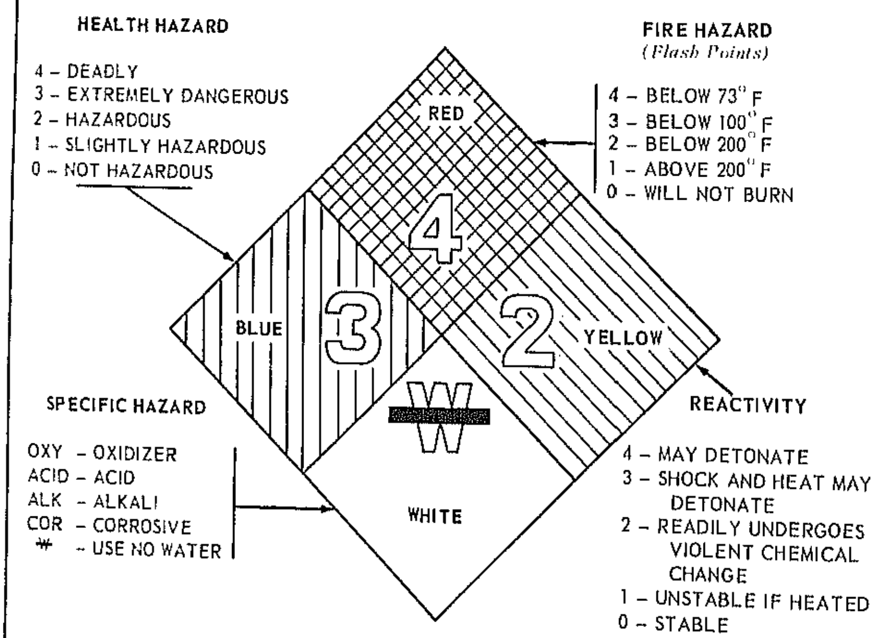
Dangerous cargo may be loaded before or after other cargo, provided all precautions are taken to assure full protection against articles being dropped from cargo slings. When possible, hatches should be partially covered to afford added protection. When military explosives are stowed in a hold below one in which any cargo is being worked, the 'tween deck hatch dividing the two holds must be securely in place.

Hatches, cargo port, and doors into compartments and holds must be closed except when actually in use. Hatches and cargo ports need not be closed during short work stoppages such as for lunch breaks. However a safety line should be placed across the opening when not working cargo.

Cargo nets with pieplates or other bases must be so loaded that when lifted, a minimum displacement of items occurs. The cargo net must completely encompass the load, except on its topside. Not more than one-third of the vertical dimension of any package may extend above the sideboards of a tray or skipbox. Drafts must b handled carefully and must be deposited only o a mattress, thrum, or 4-ply nylon mats.

Barrel slings may not be used on barrels drums, or other containers of explosives. Meta bale hooks may not be used in handling package explosives.

Mattresses or mats must be provided at th bottom of chutes, and the incline of chutes mus be such that no shock results at the bottom o from collisions. If the angle of incline is excessive personnel must be stationed along the chute to retard the speed of descent. If necessary, chutes



BLUE: IF NUMBER 1, 2, 3, OR 4 APPEARS, DO NOT STORE WITH ITEMS MARKED COR, ACID, OR ALK OR WITH FOOD CLOTHING, OR TOBACCO.

RED: IF NUMBER 2, 3, OR 4 APPEARS, STOW IN FLAMMABLE STORAGE AREA; IF NUMBER 1 APPEARS, STOW IN SPRINKLER PROTECTED AREA.

YELLOW: IF NUMBER 1, 2, 3, OR 4 APPEARS, HANDLE WITH CARE AND STOW IN COOL PLACE.

WHITE: IF COR, ACID, OR ALK APPEARS, STOW IN ACID LOCKER OR CORROSIVE STORAGE; DO NOT STOW WITH ITEMS HAVING HEALTH HAZARD. IF OXY APPEARS, DO NOT STORE WITH ITEMS HAVING FIRE HAZARD. IF ₩ APPEARS, DO NOT STOW IN SPRINKLER PROTECTED AREA NOR USE WATER IN FIGHTING FIRE.

Figure 4-14.—Hazard identification symbol. 58.177

may be lubricated by rubbing with rags moistened with machine oil.

Containers must not be dropped, dragged, tumbled, walked, slid over each other or over the deck, or otherwise subjected to shocks. Heavy containers equipped with pulling bar assemblies and skids, however, may be positioned in holds by using bar assemblies and skids to maneuver the containers for short distances at slow speed. Containers must not be rolled unless rolling is specifically permitted. Bombs may not be handled by attaching ship's cargo gear to lifting or suspension lugs.

Drums of liquid or wooden cases holding containers exceeding 1 quart of liquid may not be stowed as beam fillers. Wooden barrels and boxes and fiberboard boxes with containers of less than 1 quart capacity may be stowed as beam fillers if they can be stowed with the proper side up.

Gas cylinders may be handled (1) in trays or skipboxes with sides high enough to prevent the bottles from falling, (2) in small-mesh cargo nets, (3) strapped on pallets, or (4) with bridle slings with a round turn around each end of the cylinders.

HAZARD IDENTIFICATION SYSTEM

A mark that appears on hazardous items makes easier the task of identifying and deciding how to stow dangerous cargo. This mark is known as the hazard identification symbol and was devised by the National Fire Protection Association. The Navy's version is shown in figure 4-14. An abbreviation appearing in the white diamond identifies the type of danger. The barred W shown warns the firefighter not to use water to extinguish a fire in this cargo. A number in any of the other diamonds indicates the degree of danger. A zero in a diamond tells that that type of danger is negligible. Table 4-1 amplifies the code shown in figure 4-14.

Department of Transportation (DOT) hazardous labels could also appear on shipping containers of hazardous materials. Since you may see either version, you should be able to identify the symbol regardless of which is used. The DOT's version is shown is figure 4-15.

A number at the bottom of a label without any name identifies the material in the container. Table 4-2 lists the numbers and corresponding materials.

Table 4-1.—Hazard Table Used With the Hazard Identification Symbol

	HEALTH HAZARD (Blue Diamond)		FIRE HAZARD (Red Diamond)		REACTIVITY HAZARD* (Yellow Diamond)
4	Very short exposure could cause death or major residual injury, although prompt medical treatment is given.	4	Will rapidly or completely vaporize at atmospheric pressure and normal temperature or will readily disperse in air and will burn readily.	4	Readily detonates or is capable of explosive decomposition or reaction at normal temperatures and pressures.
3	Short exposure could cause serious temporary or residual injury, although prompt medical treatment is given.	3	Liquid or solid that can be ignited under almost all temperature conditions.	3	Can be detonated by a strong initiating source or when heated under pressure; or reacts explosively with water.
2	Intense or continued exposure could cause temporary incapacitation or possible residual injury unless prompt medical treatment is given.	2	Must be heated moderately or exposed to relatively high temperatures before igniting.	2	Unstable and readily undergoes violent chemical change but will not detonate; or may react violently with water or may form potentially explosive mixture with water.
1	Exposure would cause irritation but only minor residual injury, even if no treatment is given.	1	Must be heated before igniting.	1	Normally stable but can become unstable at high temperatures and pressures, or may react with water, releasing energy (not violently).
0	Offers no hazard beyond that of ordinary combustible material.	0	Will not burn.	0	Normally stable even when exposed to fire; will not react with water.

*Possible reaction from shock or when heated or brought into contact with water.

Figure 4-15.—Department of Transportation hazardous labels.

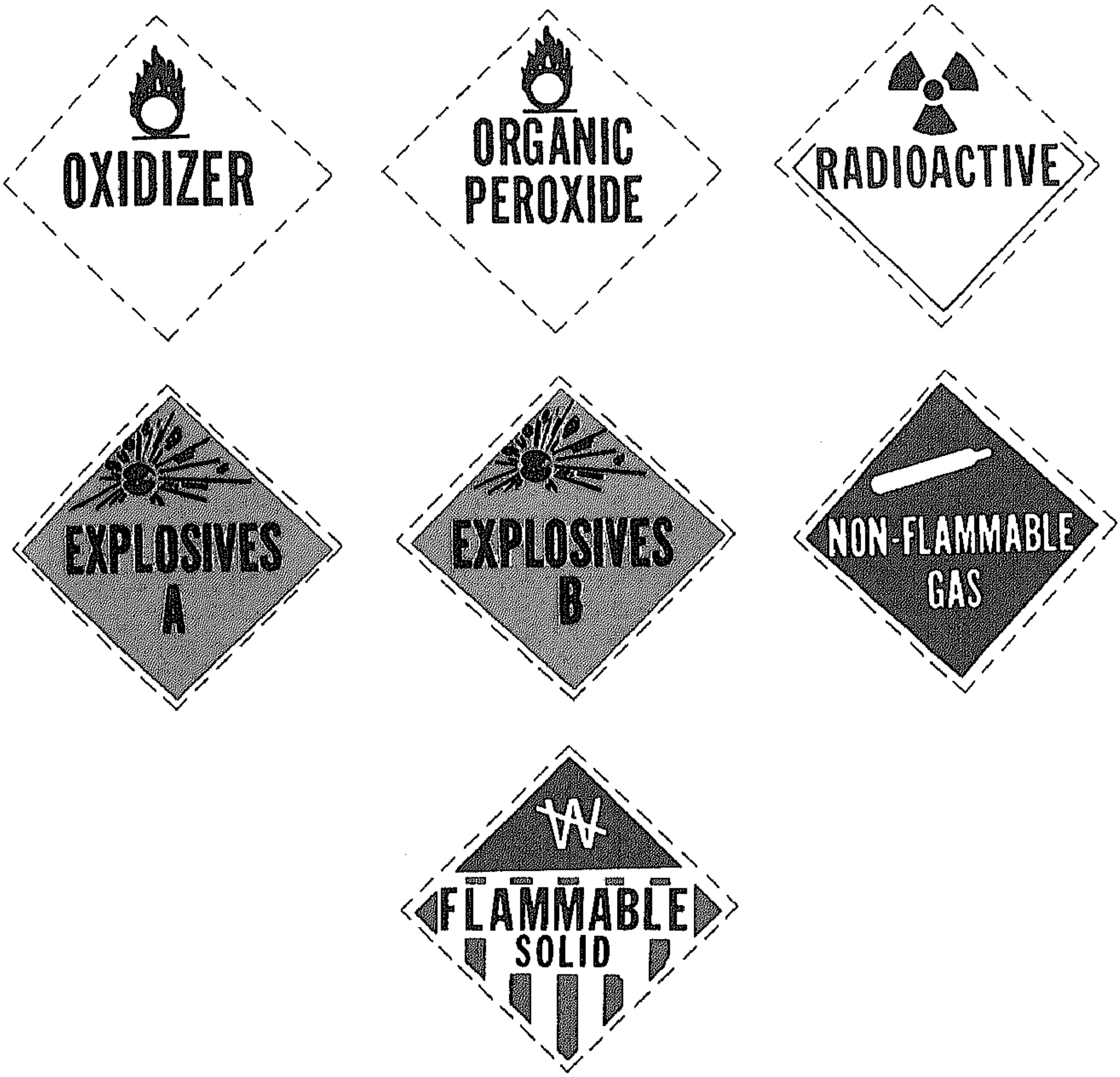


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Figure 4-15.—Department of Transportation hazardous labels—Continued.

Table 4-2.—Department of Transportation Numbers and Corresponding Hazardous Materials

1. Explosives
2. Gases
3. Flammable and Combustible liquids
4. Flammable solids
5. Oxidizers and Organic peroxides
6. Poisons
7. Radioactive materials
8. Corrosives

CHAPTER 5

UNDERWAY REPLENISHMENT

Underway replenishment rigs and associated equipment were discussed in the rate training manual *Boatswain's Mate 3 & 2*, NAVEDTRA 10121-G. In this manual we are concerned with underway replenishment from the standpoint of the supervisor. We will discuss such subjects as training, replenishment checkoff lists, and safety.

TRAINING

An underway replenishment station crew must be able to function together as smoothly as a guncrew; the crew must be so well-trained that they can work with crews on the ships alongside—crews they may have never seen. To attain the degree of teamwork and coordination necessary for a successful replenishment operation, all personnel must be letter perfect at their tasks and must know what each of their team members is doing.

Assign your crew with care—the more able to the more exacting tasks. Keep an up-to-date list of the jobs at each station and the persons trained to do them. Once a team is trained, begin shifting personnel temporarily so each person is trained at as many duties as time and his or her abilities allow. To ensure that trained supervisors are ready to take over in an emergency, give your more senior BMs opportunities to take charge of fueling and transfer operations while you stand back to observe and assist. Remain alert, but do not move in unless the petty officer in charge asks for help or circumstances indicate that the PO cannot handle a developing crisis.

Before the underway replenishment evolution, question personnel breaking in on new positions to ensure that they understand the general procedures and know their specific duties. Review the safety precautions for your crew. Young persons may be heedless about safety by taking risks—both carelessly and purposely. Therefore, you and your petty officers must be constantly alert, consistently correcting each breach of safety precautions.

As the evolution progresses, observe your personnel, make mental notes of good and poor performances. Ask your division officer and petty officers to do the same. After the evolution, conduct a critique. Discuss the operation, praise those who performed well, and constructively criticize those whose performances were not up to par. If necessary, have your petty officers reinstruct those who performed poorly. Give personal attention to those who violated safety precautions, particularly anyone who may have done so deliberately.

NAVSEA indicates that some of the new replenishment-at-sea equipment is not being used to best advantage. At times, the new, more efficient equipment and methods are being ignored in favor of older, slower but more familiar methods. This practice negates the efforts of engineers who work hard to perfect more effective hardware to speed up and make tedious, dangerous work safer. For these reasons, all Boatswain's Mates should be willing to try new methods, take time to learn them to best advantage and, thereby, gain confidence in them. You will find that in the long run you will save time and work in greater safety.

NAVSEA welcomes constructive criticism, and because you, as Boatswain's Mates, are the ones with the opportunity to use the equipment and observe any shortcomings it may have, NAVSEA personnel ask that you learn to evaluate

such equipment with an eye toward improving it and the methods for using it.

If you do see ways of improving equipment or procedures that will make an evolution more efficient or safer, discuss your ideas with the boatswain and first lieutenant. If they see merit in your ideas, they will bring the matter to the attention of the proper people in NAVSEA.

CHECKOFF LISTS

An important asset to you as a supervisor is the underway replenishment checkoff list. It is a detailed list of what must be accomplished and what equipment must be on station to conduct a safe and successful underway replenishment operation.

Each ship should promulgate replenishment checkoff lists that reflect the individual ship's requirements. Part of your responsibility as a supervisor is to closely monitor your checkoff lists to ensure they are current.

DEPARTMENTAL CHECKOFF LISTS

Each department involved in underway replenishment should have a checkoff list to ensure that a maximum condition of readiness is maintained for any incoming replenishment evolution. Figure 5-1 shows an example of a deck department checkoff list.

REPLENISHMENT STATION CHECKOFF LISTS

Checkoff lists vary to reflect the equipment needed and the procedures to be followed, depending on what is being transferred. Figure 5-2 (personnel), figure 5-3 (fuel) and, figures 5-4 and 5-5 (cargo) show examples of replenishment station checkoff lists.

SUPPLEMENTAL NIGHT REPLENISHMENT CHECKOFF LISTS

Since additional equipment is required during night replenishment operations, you should keep a supplemental checkoff list for each station. Figure 5-6 shows an example of a night replenishment checkoff list.

SAFETY PRECAUTIONS

Underway replenishment operations are arduous and dangerous. A fitting can give way; a line or wire can part. With the great tensions developed in replenishment rigs, a fitting torn loose can fly through the air like a piece of shrapnel. A parting line can whip out at the speed of sound, either of which could readily result in serious injury or death. The untrained and the unwary can be the victims of many accidents. Yet, if all safety requirements are met, underway replenishment and other seamanship evolutions can be conducted in relative safety. As a supervisor, your primary concern is to see that operations are carried out quickly and efficiently, but safely.

General replenishment safety precautions are covered in *Boatswain's Mate 3 & 2*, NAVEDTRA 10121-G, and in *Replenishment at Sea*, NWP 14. They will not be repeated in this manual. Remember, however, if all safety requirements are met, accidents are not likely to happen. Therefore, you must know all the requirements, observe them religiously, and consistently enforce them.

REPLENISHMENT CHECKOFF LIST/DECK DEPARTMENT

1. Receive and review all station checkoff lists. ______
2. Check each station to see that it is properly rigged for method of transfer. ______
3. Check the distance line for proper length and markings. ______
4. Ensure that material handling equipment is in place, operating, and manned (as appropriate). ______
5. See that appropriate carriers (cargo nets, skip boxes, transfer-at-sea chair, and transfer bags) are on station. ______
6. Start, warmup, and test winches. ______
7. Ensure that topping brake is set on topping lift and that preventer stoppers are in place or that pawls are engaged (as appropriate). ______
8. Rig appropriate station markers. ______
9. Have two bolos and one line-throwing gun ready for use at each station to be used. Test line-throwing gun and examine firing pin. Have projectiles and shot lines on hand. ______
10. Prepare and test sound-powered phones. ______
11. Have all personnel on station in prescribed uniform with life-jackets, hard hats, and other special clothing as required. ______
12. Rig in movable equipment and fittings that project over the engaged side and are not required during the replenishment (that is, lifeboats and sea painter). ______
13. Have lifeboat engines tested and ready to be lowered away. ______
14. Have movies, fleet freight, and mail ready for immediate transfer. ______
15. Have all specified rigs ready for use. ______
16. In freezing weather, have sand available for use on icy areas. Whenever practicable, remove ice from working areas before replenishment operations begin. ______
17. Have repair tools and emergency breakaway equipment on the station and ready for use. ______
18. Make readiness report to OOD. ______

Figure 5-1.—Replenishment checkoff list/deck department.

REPLENISHMENT CHECKOFF LIST/PERSONNEL HIGHLINE STATION

1. Inspect the highline to ensure that it is in good condition (free from weak spots, chafed spots, and dry rot). ______
2. Ensure the highline eye splice and shackle are in good condition. ______
3. Ensure that the trolley block is properly installed. ______
4. Ensure that all blocks are free and have a proper fairlead. ______
5. Ensure that inhaul and outhaul are free from weak spots, chafed spots, and dry rot. ______
6. Fake messenger down for running. ______
7. Have line-throwing gun and one bolo at each station to be used. Test line-throwing gun and examine firing pin. Have projectiles and shot lines on hand. ______
8. Rig station marker. ______
9. Have signal paddles available. ______
10. Fake down phone line and test phone. ______
11. Have required station tools available. ______
12. Inspect all safety devices on personnel transfer chair, safety release, and wire preventer; have shackle available to shackle chair to the trolley block. ______
13. Inspect stokes stretcher for restraining strap, flotation gear, and wire preventer. ______
14. Have transfer bag available (when transferring movies there will be flotation gear on the transfer bag). ______
15. Ensure that sufficient manpower is available for personnel transfers, and hold a safety lecture. ______
16. Make readiness report to the first lieutenant. ______

Remarks:

Figure 5-2.—Replenishment checkoff list/personnel highline station.

REPLENISHMENT CHECKOFF LIST/FUELING STATION

1. Ensure that open wire and whips are free of kinks and are spooled on the drums with no riding turns. ______
2. Check pelican hook for ease of operation and presence of cotter pin. ______
3. Check end fitting (that is, eye splices and span-wire weak link). ______
4. Start, warm up, and test winches. ______
5. Conduct preoperation checkout of ram tensioner. ______
6. Check topping lift brakes and wire stopper. ______
7. Rig station marker. ______
8. Ensure that only properly tested hoses are used in rig. ______
9. Conduct preoperation inspection of probe. ______
10. Check quick-release coupling for ease of operation and for condition of three actuating pawls inside the coupling. ______
11. Tighten four-inch hose cap handtight. ______
12. Place hose rig in position, *fitted on outboard end with appropriate fitting for ship to be refueled.* ______
13. Stop off messenger to probe remating line hook; fake messenger down on deck for running, rigged for the method being used. ______
14. Ensure that inboard saddle whip is led to a cleat on deck and is faked down free for running when applicable. ______
15. Ensure that saddle whips and retrieving lines are clear for running and are led to winches. ______
16. Fake down phone line and test phone.
17. Have ground wire ready if AVGAS is to be transferred. ______
18. Have signal paddles available. ______
19. Have required station tools available in accordance with NWP 14. ______
20. Have line-throwing gun and one bolo at each station to be used. Test line-throwing gun and examine firing pin. Have projectiles and shot lines on hand. ______
21. Have spare shackles, seizing wire, and small stuff for lashing available. ______
22. Make readiness report to first lieutenant. ______

Remarks:

Figure 5-3.—Replenishment checkoff list/fueling station.

REPLENISHMENT CHECKOFF LIST/HOUSEFALL STATION

1. Ensure that wires are free of kinks and are spooled on the drum with no riding turns. Additionally, ensure that winches engaging the clutch are secured in place with toggle pins. ______
2. Ensure that trolley block is properly installed (MHF). ______
3. Check operating cargo hook. ______
4. Have all swivels free and well-lubricated. ______
5. Have all shackles properly secured. ______
6. Check pelican hook for ease of operation and presence of cotter pin. ______
7. Fake housefall block messenger down for running. ______
8. Have line-throwing gun and one bolo at each station to be used. Test line-throwing gun and examine firing pin. Have projectiles and shot lines on hand. ______
9. Rig station marker. ______
10. Have signal paddles available. ______
11. Fake down phone line, and test phone. ______
12. Test all winches. ______
13. Have required station tools available. ______
14. Have cargo nets, net shorteners, skip box, and transfer bag available, as required. ______
15. Muster personnel assigned. ______
16. Make readiness report to first lieutenant. ______

Remarks:

Figure 5-4.—Replenishment checkoff list/housefall station.

REPLENISHMENT CHECKOFF LIST/MISSILE/CARGO STREAM STATION

1. Ensure that wires are free of kinks and are spooled on the drum with no riding turns. Additionally, ensure that winch clutches are engaged and secured in place with toggle pins. ______

2. Test winches and sliding block in accordance with approved SQT procedures. ______

3. Ensure that trolley, cargo drop reel, cargo hook, STAR, Concord block, or SURF are properly rigged. ______

4. Ensure that trolley support arms are pinned back and that inhaul is in tension mode. ______

5. Check pelican hook for ease of operation and presence of cotter pin. ______

6. Ensure that the messenger is faked down for running and properly attached to the rig. ______

7. Have line-throwing gun and one bolo at each station to be used. Test line-throwing gun and examine firing pin. Have projectiles and shot lines on hand. ______

8. Rig station marker. ______

9. Have signal paddles available. ______

10. Fake down phone line and test phone. ______

11. Have required station tools available (including emergency tools). ______

12. Have cargo nets, net shorteners, skip box, and transfer bag available, as required. ______

13. Muster personnel assigned. ______

14. Make readiness report to first lieutenant. ______

Figure 5-5.—Replenishment checkoff list/miss

SUPPLEMENTAL REPLENISHMENT CHECKOFF LIST/NIGHT REPLENISHMENT STAT

(Petty officer in charge of station will complete this checkoff list in addition to the station checkoff list required for day replenishment.)

1. Have at least two shot-line projectiles on hand illuminated with chemical light wand for each ship expected alongside. ______
2. Test batteries and bulbs in all flashlights. ______
3. Ensure that chemical light wand or one-cell red flashlight, whistle and dye marker are attached to each lifejacket in use. ______
4. Have station marker light box properly prepared showing correct commodity. ______
5. Have obstructions and fittings rigged with chemical light wand of one-cell red flashlights. ______
6. Have appropriate colored lens flashlights or wands available for hand signal. ______
7. Mark each messenger line with canvas tags. ______
8. Rig distance-line illumination. ______
9. Rig lifeline illumination. ______
10. Rig red cargo lights. ______
11. Ensure approach and station lights have been tested. ______

Figure 5-6.—Supplemental replenishment checkoff list/night replenishment station.

CHAPTER 6

ANCHORING AND MOORING

It is impossible to discuss anchoring or mooring a ship without discussing ground tackle. Fortunately, a Boatswain's Mate who has attained your rate has had considerable experience at handling ground tackle. Its care, maintenance, painting, inspection, overhaul, and operation have been almost everyday occurrences in any seagoing BM billet. With this experience behind you, and the information you have picked up from the *Boatswain's Mate 3 & 2* training manual, you are ready to supervise and instruct others in anchoring and mooring duties.

ANCHOR SEAMANSHIP

To bring a ship to anchor, to a buoy moor, or to a Mediterranean moor in a seamanlike manner is the mark of an efficient ship. As a generalization, you might say that this evolution consists of three main parts; shiphandling, navigation, and deck seamanship. The latter, of course, is of primary concern to you. But you also should have an appreciation of the other aspects of the evolution. Therefore, let's consider the steps as they occur when your ship prepares for anchoring or mooring.

The designated anchorage is located on the chart and the ship's position is plotted. The CO and the navigator decide on an approach course, taking into account wind, current, other ships at anchor in the vicinity, hazards to navigation, etc. Whenever possible, they also select some prominent navigational aid located at right angles to the approach course from the anchorage to use for a drop bearing. On the chart, the navigator scribes distance arcs from the anchorage which intersect the approach course—generally at 2000, 1500, 1000, 750, 500, 300, 200, 100 yards—so that there is a continuous sight reading of distance to the anchorage as the ship is plotted along the approach course. Speed is reduced progressively as the ship nears the anchorage—usually to 10 knots at 1500 yards, 5 knots at 1000 yards—and engines are stopped at 500 yards. However, these distances are relative, depending on ship characteristics, sea, and weather conditions. Some backing is usually required before the anchor is dropped.

To lay out the chain and set the anchor, the ship should always be moving slowly when the anchor is let go. This prevents the chain from piling and injuring the lower chain links or fouling the anchor. On ships with sonar domes, it is preferable to have the ship backing to avoid the possibility of damaging the sonar dome.

The approach procedure for an anchor moor is the same, except there are two anchor locations and two drop bearings. Where possible, the line connecting the two anchoring locations should be parallel to the prevailing wind direction or to the direction of currents for that area, whichever is more important. Also, where possible, this line should be projected back to become the approach course, especially in the final stage of approach.

When making preparations to let go, make certain that the anchor buoy line is made up in such a way that it can pay out freely. Detail a seaman to toss the buoy overside on the order to let go. Instruct the seaman to report whether the anchor buoy is watching.

As BM in charge, you should make it one of your responsibilities to see that the jack is hoisted promptly and that it is right side up.

Upon letting go the anchor, ensure that colors are shifted, boats lowered, boat booms swung out, and accommodation ladders lowered. Other ships in the vicinity gage the smartness of

your ship by the skill with which these tasks are performed.

LETTING GO AN ANCHOR

The two primary means of releasing an anchor are the stopper release and brake release methods. We will discuss letting go and weighing an anchor, reports made to the bridge, and some situations you may encounter.

STOPPER RELEASE METHOD

Most ships have a vertical shaft type of anchor windlass, and let go the anchor by releasing the pelican hook on a chain stopper. Your forecastle gang will have to make extensive preparations before you can report that the anchor is ready for letting go. The special sea detail portion of your watch, quarter, and station bill sets up the stations to be manned.

After all stations are properly manned, the wildcat is engaged. Then the anchor windlass operator releases the brake and takes a slight strain on the chain. All stoppers are removed except the most forward one (housing stopper), and the pelican hook on that stopper may be shifted back one link if the anchor will not free fall. This shift, if required, is necessary to ensure that the anchor will be loose in the hawsepipe when the chain has been walked out until the stopper again has the strain of the anchor.

The brake is then set up; this tension on the brake must be released immediately when the anchor starts from the hawsepipe. The windlass then is disengaged. On the order "Stand by the anchor," a seaman with a heavy maul is stationed by the remaining stopper and another is stationed by the locking pin of the pelican hook. At the command "Let go," the pin is pulled out, the bale is knocked away and the brake is released. The seaman must jump clear at once to avoid possible injury.

When the anchor hits bottom, there will be a visible slackening in the speed of the chain through the hawsepipe. The seaman stationed at the windlass should start braking to keep the chain from piling up on the anchor. In a normal situation of bringing a ship to anchor, the prudent use of the friction brake and the sl
make laying out the chain eas
moves forward (or aft), chain is v
ing the brake until the scope p
conning officer has been reached
is set up. When the ship is fetch
is informed. The stopper is pass
by the conning officer.

BRAKE RELEASE METHOD

On ships with a horizontal sh
anchor must be let go by releasing
the devil's claw stopper is release
on its turnbuckle, and the pawl (
over to clear the chain. There is
lem in getting the anchor started
chain on deck to hold it back. I
start when the brake is released,
with a piece of timber.

All hands must keep well clear
aft line of the wildcat as the a
Otherwise, debris from the chai
sometimes comes flying over th
cause injuries to personnel.

REPORTS MADE

Once the anchor is down, it
sibility to keep the bridge inform
of the chain. The conning office
formation concerning the amoun
direction the chain tends, and stra
so that proper use of the engines a
be used.

Standard terminology is alwa
ing anchoring reports. For exa
detachable link passes the windlas
teen fathoms on deck," "Thirt
deck," and so forth. Once the cha
veering, report: "(Number) fathom
edge." With each report, include
chain is tending, and supplement
an arm motion in the direction in v
is leading. Report strain on th
strain," "Slight strain," "Heav
Report immediately when the chai
the stem, and continue veering ch
situation exists. If the brake were
were taken under those conditions,

the stem, especially detachable links, might be bent.

SCOPE OF CHAIN

It is self-evident that too short a scope of chain will tend to raise the shank of the anchor from the bottom, causing the ship to drag anchor. The reason for avoiding too long a scope is not so obvious. If a ship having too long a scope is subjected to heavy weather, a strain much stronger than normal is placed on the chain. More and more of its length lifts off the bottom as the strain increases. If the scope is not too long, the chain lifts all the way to the shank, and the anchor breaks out and drags before the chain parts. With too long a scope, however, before the entire length of the chain lifts off the bottom, the breaking strain is reached and the chain parts.

ANCHORING NOMOGRAPHS

Anchoring nomographs have been prepared to determine the minimum scope and the horizontal distance from the ship to the anchor. These nomographs represent the data used to determine the required scope of anchor chain, ship's resistance, and distance from anchor to ship. The nomograph is a tool for determining the foregoing without resorting to calculations. Anchoring nomographs apply only to the class of ship for which they are prepared. If nomographs are not available, they may be obtained from NAVSEA.

Information for using anchoring nomographs may be found in Naval Ships' Technical Manual (NSTM), chapter 581. Figure 6-1 shows an example of an anchoring nomograph.

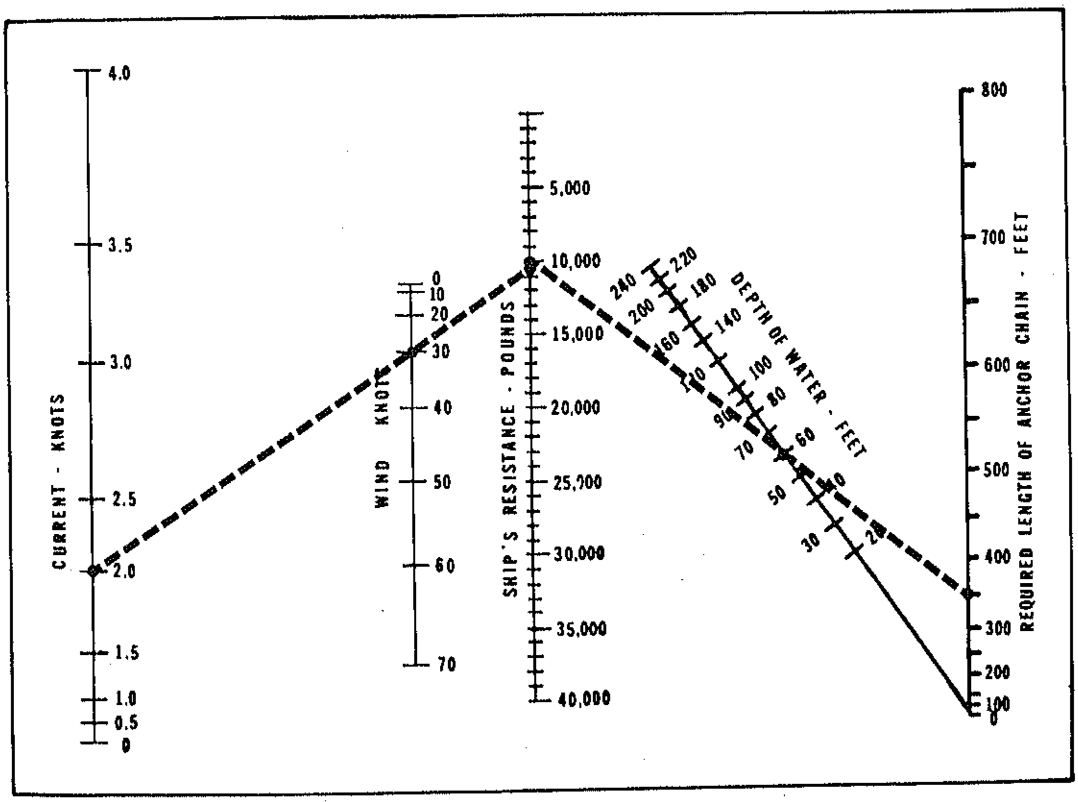


Figure 6-1.—Anchoring nomograph example.

ANCHORING IN DEEP WATER

When you are anchoring in deep water, the approach to the anchorage should be made at a very low speed. During the approach, the anchor must be walked out to within a few (5 to 20) fathoms of the bottom and then let go. Even with the anchor close to the bottom, the chain's weight will cause it to run out wildly when the anchor is let go. Under such circumstances, it is easy to lose the chain. Therefore, exceptional care must be used to keep the chain under control by intelligent use of the brake.

At extreme depths (40 to 50 fathoms) it is advisable to walk the anchor all the way to the bottom.

HEAVING IN THE ANCHOR

When the special sea detail (or anchor detail) is stationed, ensure that your seamen have the necessary equipment ready for use. Equipment includes:

- Detachable link tool box
- Chain stopper wrench
- Cable jack or anchor bar
- Maul
- Wash deck hose (or firehose)
- Grapnel
- Telephone
- Paint pots and brushes for re-marking chain
- Small tarp to keep paint from dripping on flashplates
- Rags

It may not always be feasible to re-mark the chain, but with preparation, it can be done.

Before you heave in the anchor, the anchor windlass is connected and a strain is taken on the chain sufficient to slack the stoppers. The stoppers are removed, the anchor buoy is brought aboard, and heaving in begins at the command, "Heave around." If the chain has been subjected to any severe strain during the time at anchor, each link should be inspected for distortion and sounded with a hammer as it comes aboard. Each chain marker is reported as it appears. Report also the amount of strain on the chain and the direction in which the chain is tending.

The windlass should be heaved around slowly at first until the ship's deadweight is overcome and it begins to move toward the anchor. If wind or current effect is putting undue strain on the windlass, inform the bridge so that the conning officer may relieve the strain by using the ship's engines. If the chain tends across the stem, order the windlass operator to avast heaving until the ship swings clear. Here, again, the bridge can assist with engines and rudder.

All chain lockers on modern Navy ships are of the self-stowing type. However, you should have at least one seaman assigned to guard against any possible pileup in the chain locker. The chain can be kept from piling up by pushing any accumulation over with a length of 2 x 4. Be careful not to drop the 2 x 4 or anything else into the locker.

When the anchor is just about to break out, with the chain nearly vertical, the report is made, "Anchor at short stay." Just as the flukes break out, with the crown still in the mud, word is passed, "Anchor is up and down." Next comes, "Anchor aweigh!" when the anchor leaves the bottom, and "Anchor in sight; clear (or foul) anchor!" when it comes into view.

Patent anchors frequently come up with flukes inboard, and on some ships they can foul the forefoot in this position. Usually the only way this fouling can be detected is by the sudden strain on the windlass, which must be stopped instantly to avoid possibly parting the chain. A quick veer, braked to a sudden stop, will usually turn the flukes over the right way, but sometimes the anchor may require dropping again. However, most anchors will come right on in, even with flukes inboard; the ship's side around the hawsepipe turns the flukes over when the shank enters the pipe. On some ships, the inboard-pointing flukes engage the side and will prevent the anchor from housing properly. A quick veer will usually correct this situation. If not, a bull rope must be attached to a fluke and heaved from on deck to hold the flukes upright as the chain is taken in.

SPECIAL ANCHORING PROBLEMS

Occasionally, peculiarities in construction require special anchor-handling procedures. Ships

with the bow-mounted sonar must, for example, take care not to permit the anchor chain to injure the huge, expensive sonar dome mounted at the forefoot.

Ships so equipped usually have a stockless anchor at the stem and a lightweight-type on either the port or the starboard side. (See figure 6-2.)

Ships with twin screws normally prefer using the bower anchor, but single-screw ships find it easier to maneuver to keep the chain from contacting the sonar dome if the starboard (port) anchor is used.

Readying either anchor for letting go is the same as in other ships, except that a nylon pendant is dipped out the bullnose or a chock and in through the hawse. This pendant is of 8- to 10-inch nylon, 180 feet long, with a 1-1/2 inch pelican hook at one end. Some ships prefer walking out the anchor to the water's edge before letting go.

When using the bower anchor, a ship must be dead in the water or have sternway when letting go. Opinions differ about making way when using the other anchor, however. Some ships prefer headway and others sternway. The important thing is to maneuver to keep the chain from striking the sonar dome.

After the anchor is let go, the cable is veered until within 20 to 30 fathoms of the desired scope. Then the pelican hook of the nylon pendant is attached to the chain, and pendant and chain are veered together. When 15 fathoms of pendant are out, the pendant is secured on the bitts, and 5 to 15 more fathoms of chain are veered before passing the stoppers. This chain hangs in a bight inboard of the pelican hook (figure 6-3). Thus, the ship rides to the pendant, and no chain under strain can contact the sonar dome.

No particular problems are experienced in heaving in, but it is essential that no headway be made until the anchor is clear of the water.

MOORING

The word "mooring" as used in the Navy includes both mooring to a buoy and mooring with two anchors. In today's Navy, mooring to a buoy is used more frequently, as mooring buoys have been installed in nearly all locations where ships previously were required to use an anchor moor. As a Boatswain's Mate, however, you are required to be familiar with the process of making an anchor moor by any of the accepted Navy methods. Mediterranean, foul weather, and buoy moors will be discussed in this chapter.

MEDITERRANEAN MOOR

The Mediterranean moor consists of dropping both anchors, widely spaced, and backing the stern into a pier or mole where it is secured by a stern line and two quarter lines, preferably crossed under the stern. This moor allows greater use of dock space and enables each ship to place its own brow to the pier.

For best security of the moor, the chains should tend 60° out from each bow, but crowded harbor conditions seldom allow such separation. Frequently it is necessary to settle for as little as 30°. Even 30°, however, gives a secure moor for all except the most severe winds.

Because ships with only one anchor windlass experience the most difficulty with this moor and because ships larger than destroyers usually have a tug to assist, we will discuss the moor as made by a destroyer.

The first item in preparing for a Mediterranean moor is to decide how far from the mole to drop the anchors. This distance depends on the length of the ship, the amount of chain to be used, and the angle that the chain will tend.

It is desirable to have the anchors well out because with only one windlass, the anchors must be worked one at a time. Safety requires that this time-consuming task be accomplished as far from shore as possible. A good scope of chain is 75 fathoms, allowing a 30-fathom margin for error on the shorter chain (105 fathoms).

With a 390-foot destroyer using 75 fathoms of chain, and the stern close to the mole when

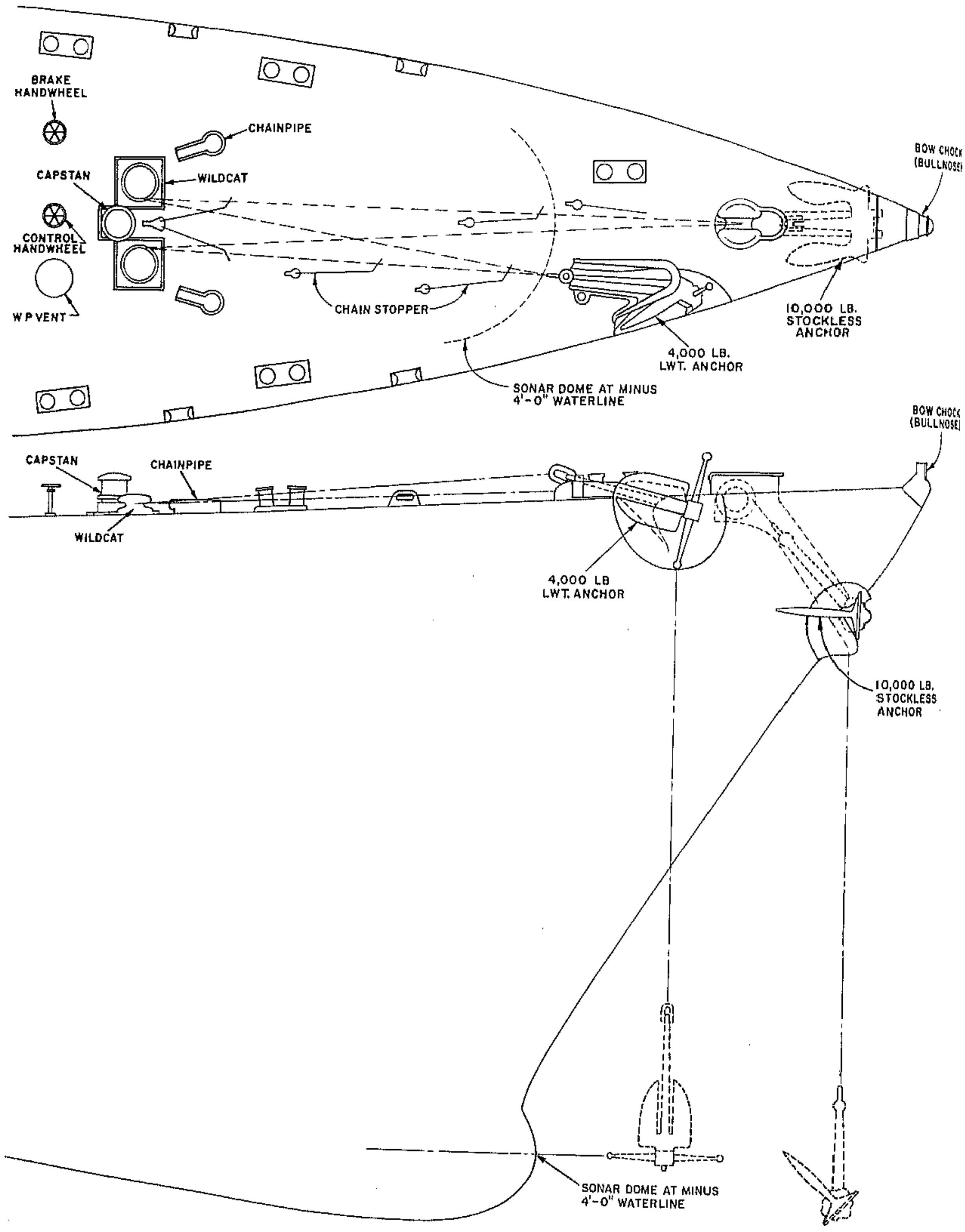
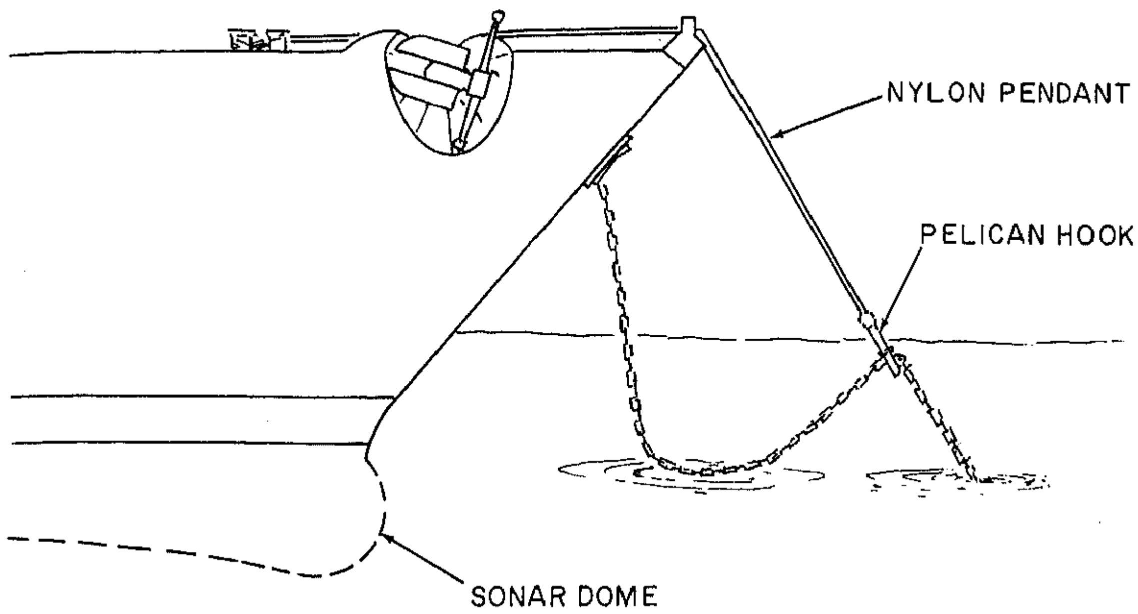


Figure 6-2.—Anchor handling arrangement on a destroyer with a bow-mounted sonar dome. 58.170



58.178

Figure 6-3.—Use of nylon pendant in anchoring a destroyer with a bow-mounted sonar dome.

secure, the anchor should be dropped approximately 280 yards from the mole (figure 6-4). The most advantageous approach is parallel to the mole. The first anchor should be let go when the hawse is about 50 yards short of the centerline of the berth and the second let go when the bow is about 50 yards past the line. After dropping the first anchor, the rudder is put hard over to prevent the chain from getting under the ship. After letting go the second anchor, the ship is twisted and backed toward the mole, veering chain as necessary. The chain of the first anchor should be handled on the wildcat, and the other can be handled from its compressor.

(For the benefit of those BMs who are not familiar with the rig, a chain compressor is a lever-like device mounted in an opening in one side of the chain pipe. When set up, it holds the chain against the opposite side of the pipe. The force is applied by means of a light tackle secured to the end opposite the fulcrum. It provides an auxiliary means of controlling and securing the chain.)

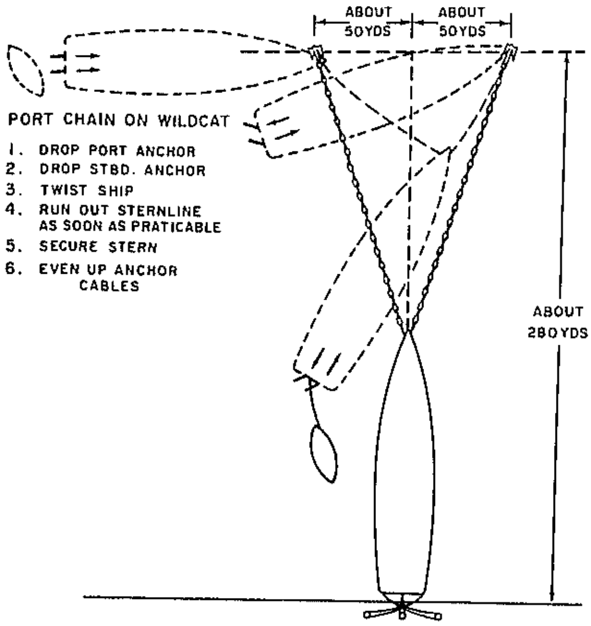
As soon as possible, the stern line should be run to the mole, and particular care must be taken to keep the slack out of this line lest it become fouled in the screws.

If the construction of the stern permits, the quarter lines should be crossed, as this ensures a more secure moor.

After the stern has been secured, the moor is made taut by heaving in and equalizing the strains on the anchor chains. Both chains must take a moderate strain and stand well out of the water to hold the stern off the mole.

FOUL WEATHER MOOR

An approaching storm warrants the attention of all hands. The preferred course of action is to seek the open sea. If that is not possible, the ship must ride out the gale at anchor as best it may. The first step in combating this danger is to veer to the safe maximum scope of chain. As an experienced seaman, you no doubt have witnessed the pronounced yawing of a ship riding to a single anchor. During a violent storm, this yaw may be as great as 80°, and a ship is in great danger of dragging anchor or even parting its anchor chain. Dropping a second anchor underfoot will



3.227(58)C

Figure 6-4.—Steps in making a Mediterranean moor.

greatly reduce this surging. But a better method of ship control is the foul weather moor (also known as the hammerlock moor).

There is no special problem in accomplishing this moor. You merely make a second anchor ready for letting go. The key to the operation is the spot at which the second anchor is dropped. Location of the drop point is determined by the predicted path of the storm.

The most desirable situation is to present to the wind the open end of the V formed by the anchor chains. To accomplish that, you must take into consideration your position on earth and the direction to which the storm will pass.

All storms rotate, winds within them blowing in a circle rather than a straight line. Hence, in relation to a fixed position on earth, the direction of the wind shifts as the storm moves along its course. In the Northern Hemisphere, the wind direction is counterclockwise and in the Southern Hemisphere, clockwise. Thus, in the Northern Hemisphere, if the storm is expected to pass to the east, use the starboard anchor as the riding anchor. If it will pass to the west, use the port anchor. In the Southern Hemisphere, the rever is true.

If the ship is riding to the wrong anchor whe information on the storm is received, heave in an drop the correct anchor. Otherwise, merely read the secured anchor for letting go and veer th riding chain to the proper scope.

When the ship has begun to yaw, drop th second anchor at the end of the arc that bears i the direction from which the wind is expected t change its own direction. Dropping the secon anchor in this position will ensure a wide out-of step moor (the underfoot anchor not in line wit the ship and riding anchor). Veer the chain of th second anchor to about 10 fathoms more than th depth of the water. More chain may be used fo a better drag, but do not pay out a scope that wil allow the anchor to hold.

Figure 6-5A shows a ship with a foul weathe moor, storm passing to eastward (backing wind)

The ship is riding to the starboard anchor. Th port underfoot anchor with 20 fathoms of chair is slowly dragging because of the chain's shor scope. A longer scope would permit the ancho to hold, but that is not desired. Althoug dragging, the underfoot anchor holds the bow steady against the wind and prevents yaw. Its drag allows the ship to swing slowly as the wind changes direction. Figure 6-5B illustrates the same situation, but with the storm center passing to westward (wind veering).

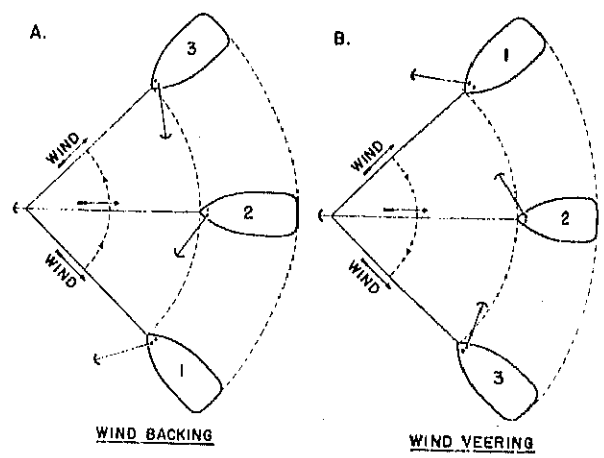


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Figure 6-5.—Foul weather moor.

Should the storm depart from its predicted track and pass on the side opposite to the one you are prepared for, you will still have a foul weather moor. In that case, the underfoot anchor will pass underneath the riding anchor chain as it drags. There is no appreciable danger that the chains will become fouled, but to prevent that possibility, the underfoot anchor should be weighed as soon as the weather moderates.

BUOY MOOR

A pad eye on the top of a mooring buoy contains a large ring to which a ship shackles its anchor chain.

Upon approaching the buoy, the ship lowers a boat containing a buoy party of three or four seaman, each wearing a lifejacket and hard hat. The ship reduces headway so as to come to a dead stop with the bow half a ship's length from the buoy. The boat brings its stern under the ship's bow. The end of a 5-inch dip rope and the end of a 2-1/2 inch messenger are lowered to the boat, together with the eye of about a 1-3/4 inch wire containing a mooring hook or a shackle large enough to engage the ring of the buoy. The boat proceeds to the buoy, and two seamen get on the buoy. The buoy party secures the wire to the ring of the buoy by means of the mooring hook or the shackle. The dip rope is passed through the ring and bent to the messenger which is used to haul the end of the dip rope back on board. The buoy party gets back into the boat while the ship hauls its bow over the buoy. The seaman must not remain on the buoy during this process, because the buoy always cants and, at times, spins.

The chain to be used already has been disconnected from its anchor, and the mooring shackle secured to it by means of a detachable link.

One end of the dip rope is bent to the chain just above the shackle, and the other is led to the capstan. By walking out the chain and heaving on the dip rope, the shackle is maneuvered out to the buoy. When the end of the chain is in position, the buoy party should be ready to secure it to the ring. When that is done, the buoy party casts off the wire, and the moor is complete.

The above is only a general description of the routine for mooring to a buoy; there may be variations in certain particulars.

Trolley Method

As you learned in *BM 3 & 2*, the trolley method is a simple method for easing out the end of the chain to the buoy by letting it slide down the wire shackled to the buoy.

One or more shackles over the buoy wire are used as trolleys. The chain is connected to these trolleys by means of short wire straps passed around studs of the chain links (figure 6-6).

The first trolley is connected to the fourth or fifth link, providing enough chain for the buoy party to complete the moor without difficulty.

Other preparations on deck are much the same as for the ordinary method of mooring to a buoy, except that sufficient chain for the maneuver is roused up and allowed to hang in a bight over the side during the approach. It is not necessary to use a dip rope. The easing-out line, in addition to controlling the travel of the chain during the mooring operation, also prevents the bitter end of the chain from dropping into the water during the approach.

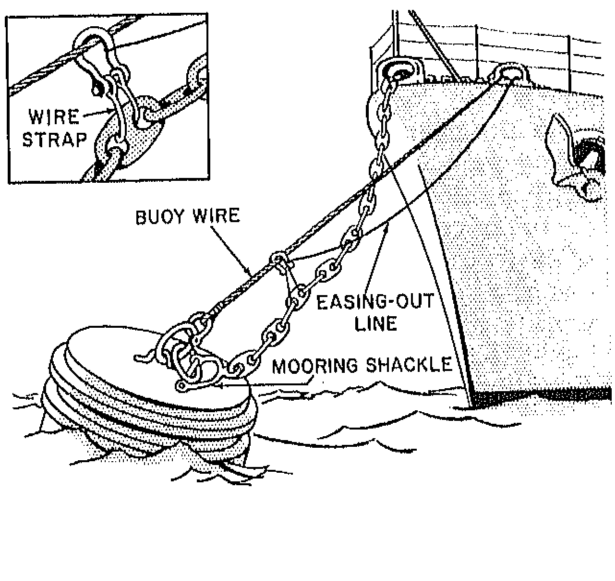

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Figure 6-6.—Trolley method.

With this method, the buoy party in the boat takes only the end of the wire to the buoy. It is either shackled directly to the ring of the buoy, or a short wire strap is passed through the ring and the eye of the wire. The ends of the strap are shackled together. The buoy party should always be provided with a strap when the size of the ring on the buoy is not known. If possible, connect the buoy wire to a ring other than the one to which the chain will be shackled.

The ship should be maneuvered to stop with the bullnose abreast of the buoy and about 10 yards away.

Once the buoy wire is secured, it is heaved taut and kept that way. The chain is allowed to slide down the wire by slacking off on the easing-out line and the mooring shackle is secured to the ring of the buoy. The wire is slacked, cast off, and the moor is complete.

On ships with unusually large and heavy chain, it is a good idea to pass a line from the deck through the ring of the buoy and secure it to the mooring shackle or the first link. Then, by using this line and the easing-out line, the seamen on deck are able to assist the seaman on the buoy to get the mooring shackle into position.

Bow and Stern Buoy Moor

The bow and stern buoy moor is used by all navies. It is seen and used throughout the world where harbors are small and congested, or in areas where ships are out of service. It eliminates the need for any involved rigging process but, since it leaves the ship hanging in the bight of a span, the buoys must be well anchored.

In this type of moor, mooring the ship's bow to the forward buoy is accomplished in the same manner as described under "Buoy Moor." At the same time, a stern line or wire is run to the stern buoy. The ship approaches at an angle of about 20° to the two buoys' geographical line of bearing. While lines are being passed to the bow buoy party, similar lines are being passed from the ship by boat to the stern buoy party. After the lines are made fast to the buoys, adjustments are made from on deck to spot the ship equidistant, bow and stern, from the respective buoys. Most ships use a chain forward and a wire rope aft.

CARE OF GROUND TACKLE

Once each quarter, and more often if necessary, anchor chains should be roused out and examined throughout their entire lengths. Chains 1-1/2 inches and smaller may be ranged on deck. For larger chains, use a barge, drydock, or any other suitable space. If necessary, the chains should be scaled, cleaned of rust, and painted in accordance with NSTM, chapter 581.

Detachable links should be disassembled and examined for excessive wear or corrosion, and where conditions warrant, the links should be replaced by new ones. Detachable link parts are not interchangeable, so matching numbers are stamped on the C-link and on each coupling plate to ensure identification and proper assembly. These numbers are difficult to see, however. Therefore, you may save yourself some trouble if you disassemble only one link at a time and clean, slush, and reassemble it before disassembling another. The slush used is a mixture of 40 percent white lead and 60 percent tallow by volume.

The detachable link in the outboard swivel shot is fitted with a corrosion-resistant steel locking wire which serves to hold the taper pin in position. Always keep several spares in your detachable link toolbox.

Shackle bolts and pins, locking pins, and swivels should be examined carefully and put in order. Coat threads with a mixture of graphite and grease or white lead and tallow.

The turnbuckle in a chain stopper requires frequent attention. Keep it clean and free from rust, and well-lubricated with a graphite grease or white lead and tallow.

At least once every 18 months, all anchor chain, regardless of size (including shackles and detachable links), must be examined, overhauled, and placed in a good state of preservation. To distribute the wear uniformly throughout the entire length of the chain, the shots should be shifted to new positions, as necessary. If serious defects are discovered, they should be brought to the attention of the Naval Sea Systems Command. If impractical to make immediate replacement, the defective shots should be shifted to the inboard end of the chain. Make the proper entries in the anchor log.

Even though the engineering department has the major responsibility for the anchor windlasses, you should assure yourself that they are kept in good operating order. Make certain that the brakes work easily and that the braking surfaces are free from rust and grease.

If the windlasses are used infrequently, check them at regular intervals. Remove the chain from the wildcat and operate it in both directions for several minutes. Make sure that grease does not become so packed between the shaft and the wildcat that it serves to bind rather than lubricate. It may be desirable to extend the interval at which the equipment is greased.

SECURING THE CHAIN'S BITTER END

For a number of years there was a widespread belief among Boatswain's Mates that the bitter end of the anchor chain was supposed to be secured in the chain locker by a weakened link or shackle. Various means were devised to carry out this nonexistent requirement—even to securing the end with sail twine.

The small grain of truth in the belief is that the breaking strength of the shackle used to secure the chain to a pad eye in the chain locker is slightly less than the breaking strength of the chain. Actually, as set forth in the NSTM, chapter 581, the breaking strength of the shackle shall approximate the weight of 300 fathoms of the chain. The breaking strength of the pad eye must be 1.75 times that of the shackle.

Table 581-2, NSTM, lists the proper size of shackle to use with each of the various sizes of chain.

CHAPTER 7

TOWING AND SALVAGE

Most naval vessels are equipped to take another in tow or be taken in tow. Each ship is furnished with a rigging plan for towing or being towed. Vessels of the same class are outfitted with the same arrangement. The leading Boatswain's Mate and supervisor should be familiar with these plans, for they provide detailed information covering the accepted rigging method for the ship.

Towing will be discussed in the first portion of this chapter and salvage in the latter part. Let's first take a look at the main problem encountered in towing.

TOWING

Practically all seagoing tows are taken astern. Alongside towing is confined to harbors and inland waterways. The great problem in towing on the high seas lies in the alternate straining and slackening of the towing hawser caused by the pitching of the ships and the tendency of the tow to sheer off or range up on the towing vessel. To compensate, the Navy uses an automatic tensioning towing machine. A towing machine is installed in all ships whose primary mission is towing.

TOWING MACHINE

The electric automatic tensioning towing machine is the type provided on ships. The machine has stowage capacity for a minimum of 300 fathoms of 2-inch wire rope and is provided with an automatic spooling device. Operation of the drum can be controlled either manually or automatically. By automatically paying out and recovering the towing hawser, the automatic tension control relieves the shocks and variations in tension which occur while towing in a seaway. The drum can be disengaged from the source of powei for free spooling when connected to the tow.

The automatic tension range of the machine is greatest when only one layer of hawser remain on the drum; it decreases about 10 percent foi each succeeding layer. Consequently, a lonį hawser has the advantage of increasing the capac ity range of the towing machine. Other advantage: will be described later.

The function of the automatic towing machin is to cushion and relieve surges on the towin hawser caused by the pitching and yawing of th vessels and the sheering of the tow. In rougl weather, when surges are frequent, the automati feature is particularly advantageous as its then constant operation avoids serious overloads an shocks on the hawser. Higher safe towing speeds with corresponding higher average tensions, ma be maintained than are practicable with fixed tov ing for the same size hawsers.

During normal operation in a moderate sea when the hawser tension is less than the tensio control setting, the driving motor is deenergize and the hawser load is held by a magnetic brake The rotary motion of the drum assembly is the resisted by heavy springs. These springs absor considerable shock but, when the tension contr setting is exceeded, an automatic rotary drui switch causes the magnetic brake to be release and permits the motor to be overhauled. Whe tension on the hawser has relaxed, a reclaimir device heaves in until the amount of hawser paye out has been recovered. The motor is the deenergized automatically, and the magnet brake is reset.

When you are towing in smooth seas, whe it is desired that the towing vessel steam at spee which will produce towline tensions consistent in excess of the automatic recovery pull

the machine, fixed towing should be used by engaging a pawl with ratchet teeth on the hawser drum. The machine is designed structurally to withstand a pull equal to the breaking strain of the 2-inch hawser when the pawl is engaged.

Most automatic towing machines are provided with a quick hawser release. When you are towing in automatic control or on the clutch-brake with the motor shut down, the hawser can be released by simply rotating the clutch-brake handwheel in a counterclockwise direction. The load on the hawser can then turn over the drum to meet a desired increase in scope or, in an emergency, to permit the entire length of the hawser to pull free of its bitter end connection.

SHIP'S TOWING GEAR

A ship not specially designed for towing—in other words, one which doesn't have a towing machine—can tow another vessel by the fixed towing method only. In that method, a ship must use its entire length of towline (600 to 900 feet), and ordinarily it is attached to the tow's anchor cable. The desired catenary is obtained by veering the chain from 30 to 60 fathoms. The tow then passes two stoppers and disconnects the wildcat. In present practice, the towline is secured on the towing ship to a conveniently located towing pad by means of a pelican hook and, in some ships, a chafing chain.

TOWING APPROACHES

The approach to a disabled ship is determined by size, type, and maneuvering characteristics of the towing vessel; how the disabled ship lies in the water; and relative drift.

Size, type, and maneuvering characteristics are important not only during approach but also during hookup. If the ship is large and sluggish, the approach must terminate in a position requiring the least amount of maneuvering during hookup. A small, highly maneuverable vessel, on the other hand, need not be so restricted in the approach, because it is better able to compensate for unexpected occurrences.

Regardless of the characteristics of the towing vessel, however, the CO must use all available facilities to determine the safest and best approach, and the wise CO will complete the approach in the best possible position for making a rapid and safe hookup.

Because maneuvering characteristics vary so widely, it is pointless to pursue this subject. See chapter 8 for a discussion on shiphandling.

The next aspect to consider in approaches is how the disabled ship lies in the water. How it lies depends on a combination of several factors—size, draft, extent of damage affecting stability or trim, state of wind and sea, extent and location of superstructure sail area, and ocean current. If stability is not greatly altered, most ships will wallow in the trough in a rough sea. In a strong breeze and a moderate sea, the high part of the superstructure will act as a sail and may cause the ship to present the opposite end to the wind. For example, a destroyer comes around with its stern to the wind. Ships with a deep draft and low superstructure will be relatively unaffected by the wind and probably will lie broadside to the sea.

Relative drift may be a most important factor, and it must be established before selecting the approach. The purpose is to find the best position for the towing ship to be stationed.

To determine relative drift, the towing vessel advances on the other ship on the same heading and stops ahead or astern of it. Usually, a position astern is better because it then is easier for bridge personnel to observe the tow.

Sometimes, relative drift is readily apparent because one ship rapidly drifts away from the other. At other times, difference in drift is minute or the heading of one or both ships changes, making determination more difficult. It is a good idea, therefore, to take ranges and bearings about every 3 minutes and plot them on a maneuvering board with your ship at the center. After plotting three or four ranges and bearings, it is not difficult to find relative movement.

If the disabled ship drifts faster, the towing ship will be stationed downcurrent or downwind from the tow. If the reverse is true, the towing ship will be stationed upcurrent or upwind. The idea, of course, is that with one ship drifting down past the other, more time is allowed for connecting the towline before the towing ship will have

to reposition itself (figure 7-1). If there is no relative drift, the towing ship can take position as close to the tow as is prudent, but must not go so close that the helm cannot be put over without danger of throwing the stern into the tow.

The four basic approaches are parallel, crossing-the-T, 45°, and backdown.

Parallel Approach

The parallel approach may be used under good weather conditions when the disabled vessel's drift rate is slow. Here the towing ship approaches the tow from astern on the windward side (figure 7-2, view A). Lines are passed to the forecastle of the tow as the towing ship steams past.

The maneuvering ship usually does not pass on the leeward side of the disabled vessel because, when in the lee, it might drift down on the towing ship. If the wind is strong and the towing ship is the same size or larger than the tow, the same danger exists on the windward side. The towing ship shields the disabled ship, slowing its rate of drift, and may drift down on it.

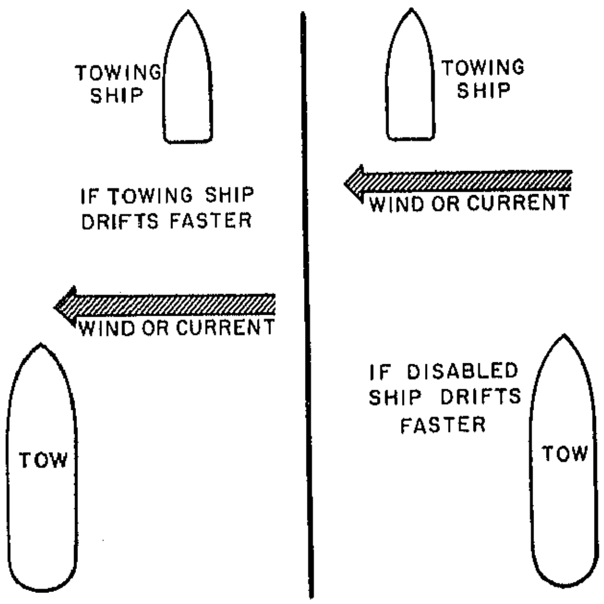

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Figure 7-1.—Using drift to gain time while connecting towline.

If there is a great difference in the sizes of the two ships, it is reasonably safe for the smaller of the two to be upwind. It will not appreciably reduce wind effect on the larger.

The parallel approach method requires expert shiphandling because the towing ship must pass close enough to send over a messenger line and then back down and stop a short distance ahead of the tow. The recommended distance ahead is one-third the length of the towline. If your ship is to pick up a tow in danger of being washed onto a beach, or if for any other reason the time required for a second pass would be disastrous, you must get the towline messenger over on the first pass. Otherwise the disabled vessel will be out of luck. However, if you have another fully equipped party near the stern, it will give you a second chance to get the towline over. If you have to resort to this action, it will be necessary to have a second section of 21-thread manila faked down on the fantail to bend onto the messenger after cutting from the messenger the section stopped off on the lifelines. This section of 21-thread must be tended and payed out carefully so that it does not wrap around a screw.

Crossing the T

Crossing the T (figure 7-2, view B) is a good approach for a twin-screw ship to use when there is a heavy sea or when relative drift rate is rapid. The towing ship uses its screws to maintain position and heading, then crosses the bow of the disabled ship on a heading almost perpendicular to that of the tow, and passes the messenger just before the bow crosses that of the tow.

A large single-screw ship should be careful with a crossing-the-T approach. If the wind is on the inboard quarter or outboard bow, it may take charge as soon as the ship stops, making it fall off into the trough 180° from the disabled ship. Usually, when the ship begins to fall off, no amount of backing and filling will stop it.

45° Approach

The 45° approach is fairly easy to make, quite safe, and can be made either from windward or leeward. As in the parallel approach, however,

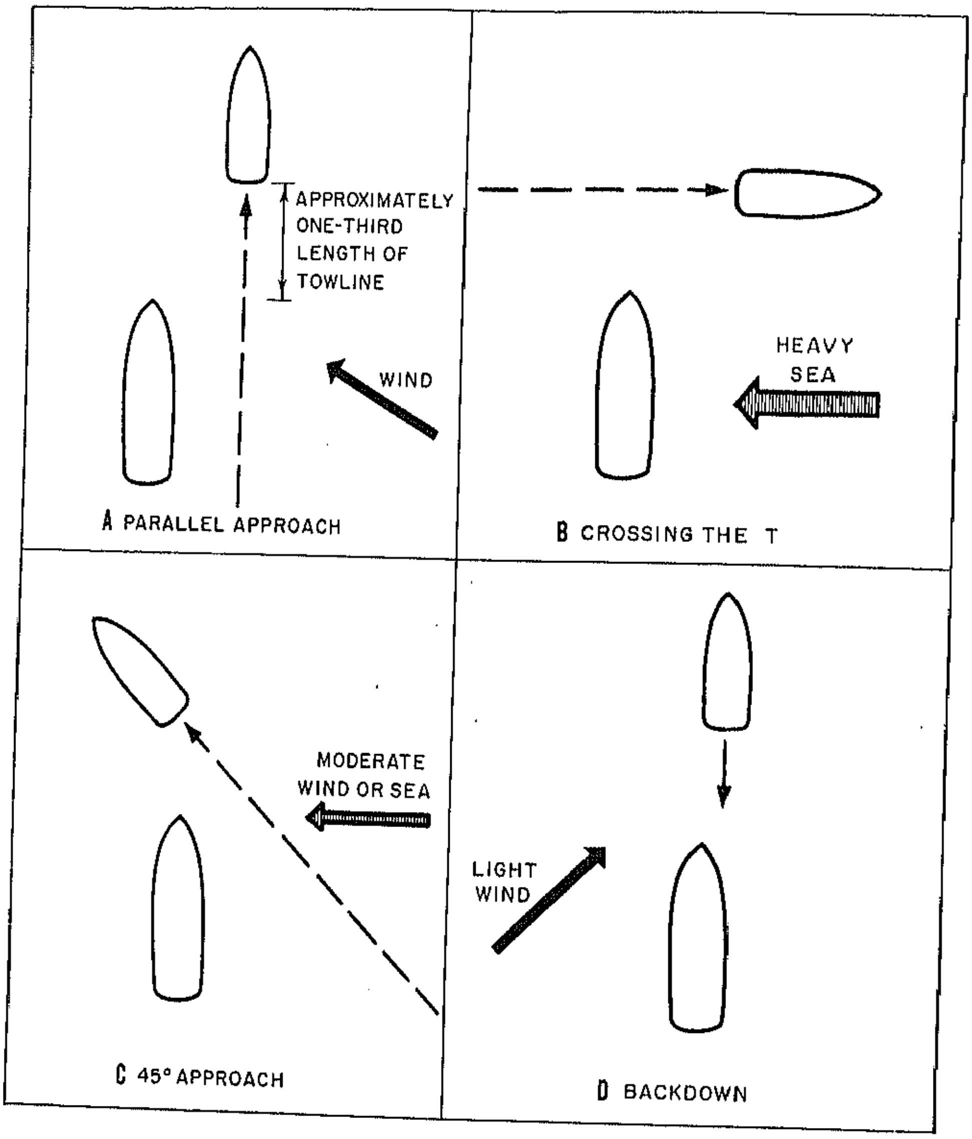

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Figure 7-2.—Four basic approaches to a tow.

there is some danger of being run down when approaching from leeward.

The towing vessel approaches on a heading from about 45° from that of the tow (figure 7-2, view C), aiming for a point (closest point of approach) about 100 to 150 feet from its bow. The messenger is passed at this point. The towing vessel should stop downwind or downcurrent from the tow if the tow is drifting faster, and upcurrent or upwind if the reverse condition is true.

Backdown Approach

The backdown or stern-to approach (figure 7-2, view D) frequently is used by vessels designed for towing. Such a vessel can back its stern under the bow of the tow and easily pass the hawser. This approach is difficult for a large, single-screw ship, however, because it will back into the wind. Then, too, relative drift may cause the two ships to separate rapidly.

Heavy Weather Procedures

Under extreme weather conditions, it may not be safe to get close enough to the tow to make any of the foregoing approaches. In such instances it is a good idea to float the messenger to the tow on oil drums, lifejackets, or powder cans. If an approach must be made, however, the towing ship should slowly pass the tow (1 or 2 knots) and stop ahead of the tow at a distance equal to about two-thirds the length of the towline. Any position closer might be dangerous, and a greater distance would preclude making the connection.

TOWING PROCEDURES

Regardless of approach, the first line run is a messenger. Towline messengers usually are made up of about 300 feet of 21-thread manila spliced to a 300-foot length of 2 1/2-inch line. For larger ships using a heavier towline, another section of 4- or 5-inch line may be added to the messenger.

When passing the towline, great care must be taken to avoid parting the shot line or messenger. Sufficient slack must be payed out to keep the line in the water, at the same time ensuring that there is not enough slack to foul the rudder, screws, or projections on the ship's side.

There always is some danger of a messenger or a towing hawser fouling the rudder or screw. An alert towing detail can prevent fouling by carefully controlling the slack and keeping the bridge informed of how the hawser tends. There is little danger of a wire rope hawser fouling a screw because the heavy wire hangs straight down and the screws set well forward of the counter. The ship even can creep astern safely, but if too much sternway is gathered, the ship will overrun the hawser.

Once the towline is shackled to the anchor chain of the tow, the chain is veered to 30 to 60 fathoms on deck to provide a good catenary. The weight of chain in the catenary acts as a shock absorber for the hawser. Two chain stoppers are passed outboard of the connecting link and some slack roused up on deck. With this arrangement, the chain can be broken in an emergency. Chain stoppers used for towing require modification to accept a locking plate and cotter pin to ensure the turnbuckle is locked and cannot work itself off the threads.

Getting Underway

When the tow signals that it is ready, the most difficult job begins—getting underway. If anything is going to part, it probably will do so now. It, therefore, is important that all hands remain clear of the hawser until the tow is moving smoothly. The towing ship starts very slowly with the minimum number of revolutions. When the tow begins to move, a few turns are added. Although some ships use a start-stop method of accelerating, usually a better procedure is to apply a smooth, steady pull, rather than a series of jerks.

If a course change must be made, the best time to do it is before the hawser takes a strain and the towing ship becomes rudder bound. At this time, it is much easier and quicker to pull the tow around. While towing, course changes must be made in small increments. If the tow is able to steer, however, there is little problem in changing course at any time.

Towing Signals

When towing, a means of communicating between the towing vessel and the tow is essential. The best way of communicating usually is by radio or electric-powered megaphones (bull horns). When radio or bull horns are not available, flaghoists can be used. A faster means is by sound signals which also may be used to supplement any other means. The following sound signals have been used in the Navy for many years.

SIGNAL	MEANING
1 short blast	I am putting my rudder right
2 short blasts	I am putting my rudder left
2 short, 1 prolonged blast	Haul away
2 prolonged, 5 short blasts	Let go
2 prolonged blasts	Go ahead
1 short, 2 prolonged blasts	Pay out more line
1 prolonged, 2 short blasts	Stop
3 short blasts	Avast hauling
2 prolonged, 1 short blast	All fast
3 groups of 5 short blasts	I am letting go

A short blast must not exceed 2 seconds' duration; a long blast must be not less than 6 seconds in duration.

SCOPE OF HAWSER

In towing in a seaway, it is important to try to keep the ships "in step"; that is, to adjust the scope of the towline, if possible, so that the ships meet and ride over seas at the same time. If the length of hawser is such that one vessel is in the trough while the other is on a crest, the towline will slacken for an instant and then tauten with a sudden jerk, producing a stress much heavier than normal.

With a towing machine, it is easy to make minor adjustments in the scope which will bring the ships into step. With the fixed method it is almost impossible, except when the towed vessel has its anchor chain shackled to the hawser. In that case, veering or heaving in on the windlass will make the necessary adjustment.

In cases where the scope of hawser veered out is within the control of one ship or the other, it should be veered to a scope sufficient to provide a good catenary, but not long enough to permit the towline to drag on the bottom. When towing a large vessel, 200 fathoms is about the minimum for a good shock-absorbing catenary. If circumstances make it impossible for you to provide a sufficiently long scope, speed must be reduced. In any event, there should never be enough stress on the towline to hoist its entire length clear of the water.

TOWING SPEEDS

The speed at which a vessel can be towed depends upon its size and type, whether or not it can provide any assistance with its own screws, sea and weather conditions, and whether or not a towing machine is being used. In general, under good conditions, a large vessel may be towed at from 5 to 9 1/2 knots.

An increase of speed may be obtained when towing a vessel if its screw is allowed to turn over. In this or in any case where a vessel with an unlocked screw is being towed, the main engine lubrication system must be in operation to prevent bearing failures when the propeller starts to turn.

In determining the towing speed, the primary factor to be considered is the towing hawser. Speed of the vessels must be kept at a point where the towing hawser will not be overstressed.

ALONGSIDE TOWING

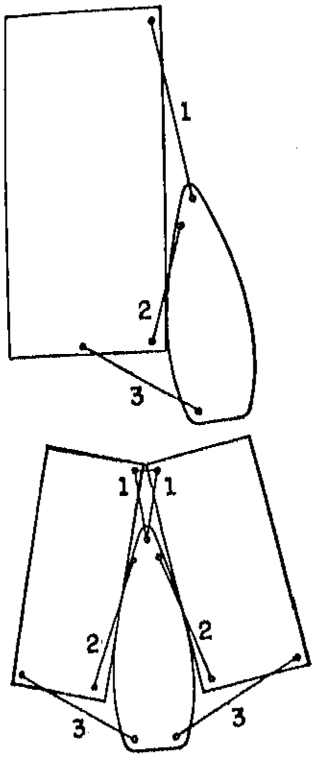
Most harbor and inland waterway towing is accomplished by tugs using the alongside method; that is, with the tug secured alongside the tow. The reason for the alongside method is the greatly increased maneuverability of a tug with the tow alongside rather than astern. If properly made fast, the tug can steer both itself and the tow, and the space required for maneuvering is much less than that required for a stern tow.

For alongside towing the tug generally secures to one side of the tow with its own stern abaft of the stern of the tow to increase the effect of its screw and rudder. The side chosen depends upon the amount of maneuvering the towing ship must accomplish with the tow. If a sharp and difficult turn is to be made under headway, the tug should be on the inboard quarter—the side toward which the turn is to be made. Here the tug is properly placed for backing to assist the turn, for as it slows, the tow's bow will turn toward the side the tug is on.

If a turn is to be made under no headway, the tug is more efficient on the starboard side of the tow. When the tug backs to turn, the (side force) of its screw will combine with the drag of the tow to produce a turning effect greater than that which could be obtained with the tug on the port side. The best position for a long back in a straight line is to have the tug on the port side, because then the drag of the tow tends to offset the side force of the backing screw.

If all turns are to be made with the tug's screw going ahead, the tug will be more favorably placed on the outboard side of the tow—the side away from the direction toward which the most turns are to be made.

The upper view of figure 7-3 shows a tug secured to a tow's starboard quarter. The towline leads from the forward bitts on the tow side of the tug to after bitts on the tow. The tug secures this line first, then ranges ahead to take up the slack. Another line, called the backing line, is led out one of the tug's bow chocks to a forward point on the tow. The tug end of this line is taken



1 - BOW OR BACKING LINE.
2 - TOWING LINE.
3 - STERN BREAST OR TURNING LINE.

1 - BOW OR BACKING LINES.
2 - TOWING LINES.
3 - STERN BREASTS OR TURNING LINES.

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Figure 7-3.—Alongside towing.

to the capstan and heaved until the towline is taut. This brings the tug to proper position, slightly bow-in to the tow. A stern breastline leading from aft on the tug to aft on the tow is used to keep the tug's stern from drifting out.

The bottom view of figure 7-3 illustrates how a tug can take two small tows alongside, one on either side.

Areas of the harbor subject to wave action should be avoided whenever possible. The tug and tow seldom pitch in the same tempo, so that, when both start pitching out of harmony, the lines take a heavy strain and may part. When equipped with a rudder, the tow assists in steering. Size and loading of the tow may be such that the view of the tug's conning officer is obstructed. In that case, a lookout is stationed aboard the tow and keeps the conning officer fully informed of activity and hazards in the blind area.

Shifting the Tow

Occasionally, it is necessary to shift a tow from one side to the other or from alongside to astern.

One method of shifting a tow from one side to the other is to drop it astern and haul it up on the other side by means of a hook rope. Following is a faster and more seamanlike method.

With the tow on the starboard side as shown in view A of figure 7-4, run a second bow line out the port forward chock, around the bow, and to the after inboard corner of the tow. Cast off the stern breast, and fake it down on the port side.

Pick up a good forward speed (about 6 knots) and apply left rudder. When the tow is in the turn (view B), stop the engine, cast off the towline, and begin to back down. With the tow crossing the tug's bow as in view C, slack the old bow line, shift the rudder, and kick ahead. As the tow comes down on the port side, steady the tug, keeping way on and allowing the tow to swing around broadside to the tug (view D). Pass towline and stern breast and set taut on all lines.

Shifting a tow from alongside to astern usually is necessary when a tug is to tow a barge or other vessel from port to port. The tow is taken alongside within the harbor and shifted astern outside.

The shifting procedure is simple. The towing hawser is connected to the towing bridle before getting underway. Outside the harbor, the lines used for towing alongside are cast off, allowing the tow to drift away from the tug. Then, slowly accelerating, carefully altering course and judiciously paying out the towing hawser, the tug gets underway with the tow and comes to the required course.

TOWING ASTERN

Towing barges and the like astern is referred to generally as tandem towing. In the broad sense, tandem means one behind the other. In towing, the term frequently is used to distinguish a particular rig for towing two or more barges or lighters in a single line. We use the term here in the latter sense to differentiate between this rig and other methods called Christmas tree, modified Christmas tree and Honolulu.

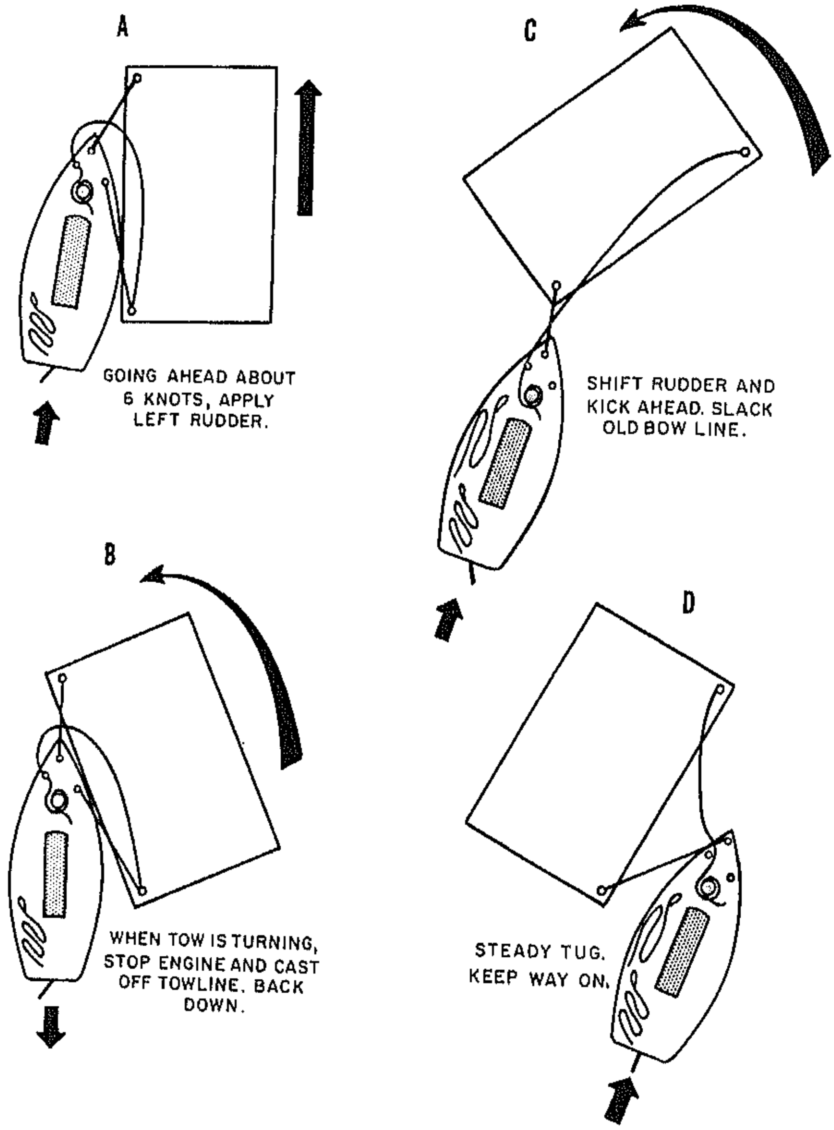

Figure 7-4.—Shifting tow to other side. 3.227(58C)E

All four of these methods of rigging for towing astern are illustrated in figure 7-5. In the tandem method, each barge tows by a line secured directly to the barge ahead. In the Christmas tree rig, all the barges tow from a single hawser by means of pendants shackled to flounders (sometimes called bails or fish plates) inserted in the towing hawser. In the modified Christmas tree rig, all units tow from a common flounder, but the last barge tows as a separate unit. The Honolulu method was devised to handle two tows, a large and a small—for example, a ship and a barge. They tow from separate hawsers.

For multiple tows, the Christmas tree rigs are preferred because they are stronger and any unit can be taken from the tow at anytime without disrupting the whole tow.

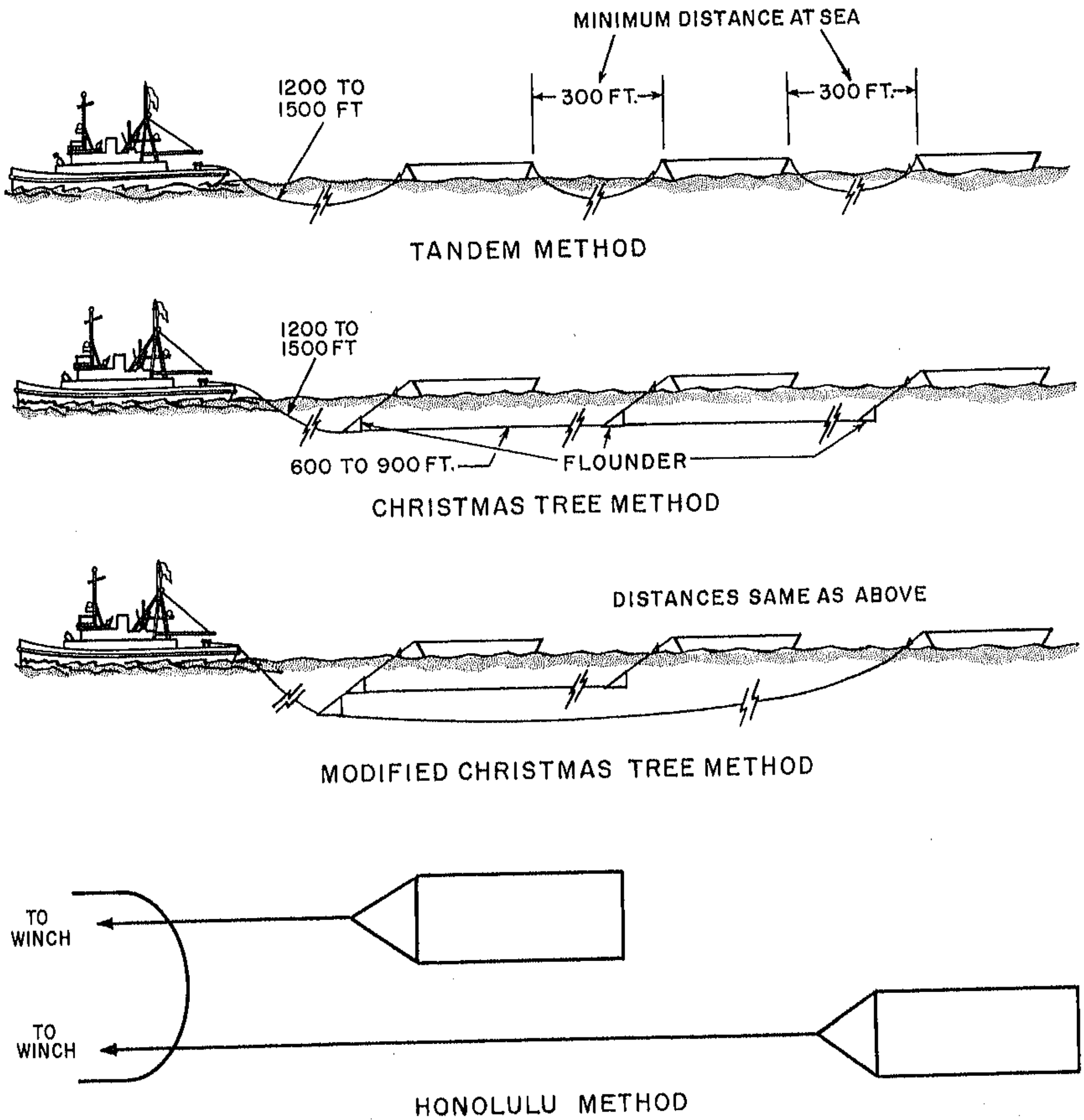

Figure 7-5.—Towing barges astern.

One item of equipment we might mention here is the plate shackle shown in figure 7-6. This type of shackle is preferred by personnel experienced in towing on the high seas because it will not work loose like a screw pin shackle. Nevertheless, for long tows, the threads of the shackle bolts should be peened over or the bolts welded in place.

Towing Bridles

Even though bridles usually are provided for barges and lighters that are to be towed, there may be times when the crew of a tug or a boat will have to fashion its own. For this reason and in the

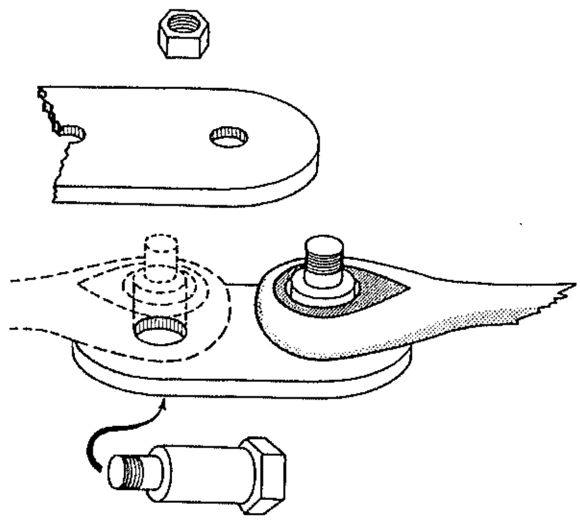

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Figure 7-6.—Small plate shackle.

interests of safety, the subject warrants a discussion at this point.

In this chapter we have emphasized the necessity for rigging and towing in such a manner as to preclude the chance of breaking the towline. This, then, sets the strength of the towline as an obvious standard to which we can equate the strength of other parts of our rig. In other words, if the breaking strengths of the other parts of the rig are equal to that of the towline, the rig is safe.

For this discussion, let us assume that the legs of the bridle are the same size as the towline. At first thought, it might seem that no further comment would be required, but such is not the case. We still must consider the angle formed by the legs.

In the chapter on rigging, we discussed the change in tension in cargo whips that accompanied the change in the angle between whips.

We told you that when this angle was 120°, the tension in each whip was equal to the load. We proved that increasing the angle increased the tension. Obviously, then, any angle greater than 120° is unsafe. Actually, the angle should not be greater than 90°, wherein tension in each leg is equal to less than 60 percent of the load. (The load in our case, of course, is the tension in the towing hawser.)

Without measuring the angle between legs, how can one be sure that the angle is not too great? The answer to that is simple. Divide the length of one leg by the distance between the points where the legs are attached to the barge. If the answer is greater than 0.7, the angle between legs is 90° or less.

This is a matter of geometry. You can prove its truth by constructing a right triangle, marking off the hypotenuse and one leg in equal units, and dividing the number of units in the leg by the number in the hypotenuse. The hypotenuse (side opposite the 90° angle) represents the end of the barge.

If the legs are the same length as the distance between attachment points, the angle between legs will be 60°, and the tension will be equal to one half that in the hawser.

SAFETY PRECAUTIONS

As a Boatswain's Mate First Class or Chief, you must be familiar with the following general and towing safety precautions.

NEVER:

Rig a towline that cannot be cast off quickly.

Make a sharp turn in shallow water with a long scope of towing hawser out, except to avoid collision or grounding.

Let tow get forward of the beam.

Tow in a heavy sea with a short scope.

Use towing hawser that is kinked or badly frayed.

Fail to cast off tow if there are definite indications that it will sink.

Abandon a tow lest it become a menace to navigation.

Take a tow without thoroughly inspecting bridle, towing pads, chafing pads, retrieving wire, cargo (safe and properly secured), and watertightness of vessel.

Allow propeller of tow to turn unless the lubrication system is working.

Trust inexperienced personnel to splice towline.

ALWAYS:

Step up speed 3 to 5 turns at a time until towing speed is reached.

Use a bolt-type safety shackle or a plate shackle to connect towline to anchor chain. (In an emergency, a screw pin shackle may be used. For short tows the pin must be moused with seizing wire, and for long tows it must be welded in place.)

Have anchor on tow ready for letting go.

Set towing watch on both ships.

Provide emergency means for cutting tow wire (large bolt cutters or cutting torch).

Keep unnecessary personnel from vicinity of towline.

Personnel involved in rigging and unrigging towing gear and handling lines shall wear lifejackets, safety helmets, and safety shoes. Personnel handling messengers and synthetic towlines MAY wear gloves, personnel handling wire rope WILL wear gloves. Rings, loose clothing, etc., should not be worn.

SALVAGE

The term salvage covers everything from refloating stranded vessels to wreck removal. World War II provides a prime example of the value of salvage operations. The U.S. Navy salvage organization during this period salvaged and reclaimed ships and equipment worth over $2 billion. Boatswain's Mates should be proud of this remarkable feat, for a good share of the credit goes to persons of that rating.

This section will present information on salvage which has been accumulated the hard way, through experience gained in hundreds of rescue and salvage jobs. On paper, a lot of it sounds easy, but take it from the experts, it's not. Each salvage operation presents its individual problems such as location, weather, degree of damage, type and shape of bottom, state of sea, tide, current, and so forth. These factors will be discussed later, but first let's take a look at some of the broader aspects of salvage.

PRINCIPAL TYPES OF SALVAGE

It is, of course, impossible to place all wrecks into a neat category. Nearly all will fall within one of four principal types of salvage. These types are:

1. RESCUE SALVAGE. Rescue salvage provides emergency salvage services to vessels and aircraft in distress at sea. The most important service is towing damaged ships to a safe harbor. Firefighting, pumping, and minor patching also are services a salvage ship can render in an emergency. Major problems are storms and gales, fire, collision, machinery failure, shifting cargo, loss of rudder or propeller, and battle damage.

2. HARBOR SALVAGE. Harbor salvage consists of salvaging ships, removing wreckage, and general salvage work in harbors. Collision is the chief cause of damage to ships in a harbor. After a collision, either one or both ships may be sunk or beached. Perhaps one of the ships sinks in the main channel, blocking the channel completely, or it sinks alongside the best pier, preventing cargo unloading. You can be sure of one thing: The Navy will be called upon to provide a salvage ship or salvage team. (In wartime, salvage teams are activated.)

Weather is another major enemy to ships in a harbor. Often a storm strikes without warning, catching harbor craft and barges with single lines out and ships anchored with insufficient chain. The results are beached barges, sunken harbor craft, and stranded ships.

Another feature of harbor salvage is that of harbor clearance away from the combat area. A

great deal of this type of salvage was performed during World War II.

Ships used for rescue salvage also can be used for harbor salvage. In addition, LCUs can be adapted to the task. This is done by equipping them with shear legs designed to lift from 20 to 30 tons. Small boats, preferably LCMs and LCVPs, are used as diving barges and small freight carriers.

3. OFFSHORE SALVAGE. Offshore salvage is concerned with refloating vessels stranded or sunk in exposed locations along a coast. Strandings occur as the result of many factors such as weather, errors in navigation, and poor seamanship and shiphandling.

4. COMBAT SALVAGE. Combat salvage consists of services rendered to an amphibious assault force and is not limited to salvage alone. These services are performed by a combat salvage group composed of one or more salvage teams and salvage vessels of all types. This group is manned and equipped to rescue personnel, retrieve stranded craft from the beach, effect emergency repairs ashore or afloat, fight fires, give emergency supplies, aid in damage control afloat, tow disabled craft, perform underwater surveys, and do repairwork in general.

THE SALVAGE PROBLEM

Offshore salvage is the most prevalent type requiring Navy assistance. It is also the most difficult and dangerous branch of salvage. Let's consider a stranding situation as being representative of problems which may be encountered in all types of salvage.

Ships run aground under any number of circumstances. In fact, no two cases are exactly alike or require the same salvage procedure. The immediate danger of further damage, however, is present in nearly all strandings. Additional damage can be caused by the ship's pounding on the bottom, being driven further on the beach, broaching to the sea, or any combination of these factors.

Pounding is caused by the varying degree of buoyancy of a stranded vessel. The waterline changes constantly as succeeding crests and troughs of waves pass the vessel. This produces an alternate increase and decrease in the ship's total buoyancy. Bottom damage occurs when this condition is great enough to lift the vessel off the bottom and abruptly drop it back again. Pounding damage ranges from a few seams opened to serious holing. In any event, it renders salvage of the wreck more difficult.

Each wave striking against a stranded vessel exerts a force on the vessel tending to drive it further inland. Bottom friction and weight inertia of the wreck are the only factors that resist this force. In addition, wind augments the force of the sea in most situations. A wreck in a pounding condition will always be moved further inland and harder aground. Even ships hard aground are lifted and moved inland by large swells. Difficulty of the salvage problem increases as the ship is forced inshore.

Stranded vessels aground forward with their sterns seaward are affected less by the forces tending to move them inland. All action possible must be taken by the ship's company immediately after stranding to maintain this attitude and keep the ship from broaching. Broaching to is a particular danger for two reasons: First, because the vessel will be driven further inshore and harder aground; second, because of the secondary currents set up around the bow and stern. These currents are of greater velocity than normal and scour sand away at the ship's extremities, piling it up amidships to leeward of the vessel. Thus, supported only amidships, the ship's back will oftentimes be broken, rendering it a total loss.

The commanding officer of the stranded vessel must consider all three of the foregoing dangers. The CO also must appreciate the necessity for taking action immediately to combat these initial dangers and prevent further damage to the stranded vessel. The following measures constitute good ship procedure in most stranding cases:

1. Make no attempt to refloat the vessel under its own power if wind and sea conditions indicate the possibility of the vessel's working harder aground, pounding, or broaching.
2. Lay out anchors to seaward to prevent the vessel from working further ashore.
3. Weigh down the vessel by flooding selected compartments and holds. This prevents the vessel from working harder on the beach and also prevents bottom damage from pounding.

)R PLANNING

salvor makes an estimate of the situation ately upon arriving at the scene of a ıg. The salvor must determine whether the steps have been taken to secure the ship, eventing it from moving further inland, ng, or broaching. As soon as the salvor is d that the wreck is safely anchored or d, steps are taken to determine as accus possible the exact physical position of the ıow the stranding occurred, and complete r and current information. Soundings are long the sides of the vessel and in the enunding area. These soundings provide the)r deciding on the direction of pull when ımes to refloat the vessel.

next step after the initial investigation is er additional information. The salvor must he equipment available on the wreck; the ·, capacity, and location of ship's winches; le power; range of tide; removable weights; nd course of vessel at time of grounding; d weight of vessel; disposition of cargo; ı and extent of hull damage, etc. With this ation, the salvor can decide on the best l(s) of salvage and, if beach gear is le, develop a layout plan (discussed later). ıethods must always be approved by the ınding officer of the stranded vessel.

\GE METHODS

s beyond the scope of this text to discuss han a few of the more common salvage ls. In fact, the number and variations of ıethods depend only on the ingenuity, skill, ɛperience of the salvor crew. Methods here are applicable in most stranding ɔns.

ƆURING CURRENT. One of the greatest getting stranded vessels off the beach is of the scouring current effect from powers. This method of scouring a channel can ıployed to advantage only when the ɛd vessel is resting on a sand, mud, or gravel ı. It has negligible effect on rock or coral. ›uring tugs are breasted alongside each ınd trimmed by the stern. Lines secure the port and starboard of the stranded vessel in such a manner that their combined screw currents are directed diagonally down and under the hull. One system commences scouring with the tugs secured amidships and, as the operation continues, the tugs are moved aft (or forward, as the case may be). Vessels with twin out-turning screws are excellent for this work. To emphasize the effectiveness of this method, we can consider a recent stranding case in New England. Here a single tug scoured a 10-foot deep channel under the stranded vessel, enabling another tug to pull it off the beach.

WRENCHING. Wrenching is another practical aid in salvage operations. As often happens, it may be that the stranded vessel is resting on a type of bottom unfavorable for scouring action; or the water may be too shallow to permit working a tug alongside. In this case, a straight pull or the wrenching method is indicated. A valuable tip to remember is that a stranded vessel can best be pulled off the beach in the direction opposite to the course held when it went aground.

A tug is usually the best type of vessel available immediately for dispatch to aid a stranded vessel. As most inshore tugs are commanded by First Class and Chief Boatswain's Mates, you are apt to be confronted with this situation. The wrenching and pulling method, then, is of particular importance to you.

While you're on the way to the scene, make all preparations for letting go your anchor. You must carry out one or more of the stranded vessel's anchors, and run out a towline, including rigging a Liverpool bridle (explained later).

When you arrive, communicate with the commanding officer of the stranded vessel. By that time the CO will have analyzed the problem and can tell you how you can assist. If the wrenching and pulling method is decided upon, your first step is to run out your towline. If possible, anchor while doing this to prevent being washed up on the shore.

Getting the messenger to the stranded ship always is a problem. At times the job can be done by means of a shot line, or even a bolo line. Salvage ships can use a pair of scuba divers to swim the messenger across the intervening water. If the surf isn't too great, a small boat will serve the purpose.

As a last resort, the messenger can be buoyed and floated to the grounded ship. When using this method, do not attempt to float the end straight down to the ship, but pay it out approximately parallel to the shore in such a manner as to use set to fullest advantage.

Figure 7-7 illustrates one method of putting set to work. The tug takes a position upcurrent from the stranded ship and pays out the messenger until the end is near the shore. Then, the tug comes about and runs past the grounded ship, paying out the messenger as it goes.

If the grounded ship has no power and a small crew, the towline also should be buoyed. It may be impossible for the crew to heave in a heavy towline that is dragging across rocks or through sticky mud.

Some suggested buoys are empty oil drums, empty powder cans, inflatable rubber or plastic floats, shoring timbers and, if nothing else is available, lifejackets. The number needed will depend upon the weight of the towline and the amount of water the buoys will displace. An empty oil drum, for example, displaces over 400 pounds of water, and a 2-inch wire rope with a fiber core weighs approximately 6 pounds per linear foot. A drum every 60 to 65 feet would be adequate in this case.

The stranded ship must be ready in all respects to attach the towline. In addition, it must be ready to let go an anchor after it clears the beach. Stranded ships sometimes come off the beach with a bound and can run down the towing vessel unless an anchor is used to prevent it.

After the towline is secured on the stranded ship, run out far enough to provide a good catenary in the towline. Then attach a Liverpool bridle (figure 7-8) to the towline by means of the carpenter stopper (figure 7-9).

The Liverpool bridle is a towline harness designed to permit a towing vessel to maintain fine control over heading and position. The lazy jacks are retrieving lines only and take no strain nor does the section of towline between the carpenter stopper and the winch. Thus, the point of tow is forward of the vessel's normal pivoting point, and it is able to maneuver to keep its head more or less into the sea. By rigging a bridle on either side, the towing point can be easily and quickly shifted from side to side to facilitate wrenching operations and to adjust to unexpected changes in current direction. Notice that the bridle on the weather or current side is used. Useful in most stranding cases, the Liverpool bridle is essential in circumstances where currents and weather make it impossible for a conventionally rigged towing vessel to maintain its station clear of reefs.

If the stranded vessel is only lightly aground forward with the stern afloat, a straight pulloff is the simplest and most direct method of

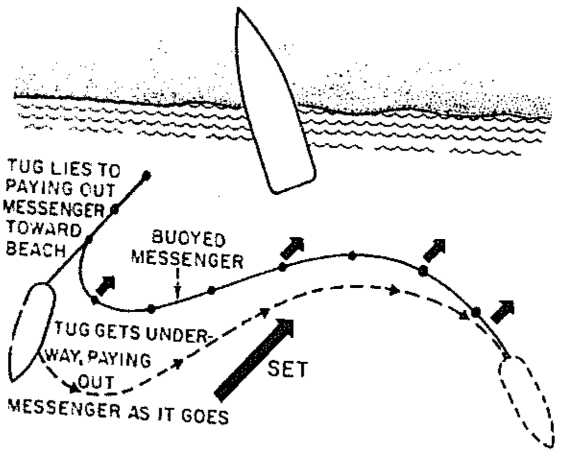

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Figure 7-7.—One method of floating a messenger to a stranded ship.

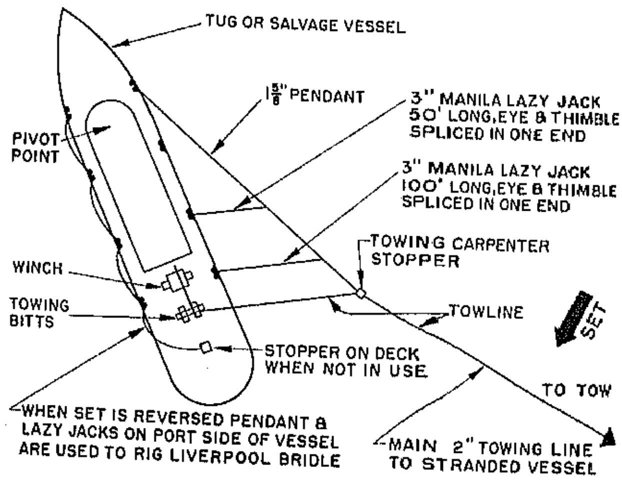

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Figure 7-8.—The Liverpool bridle.

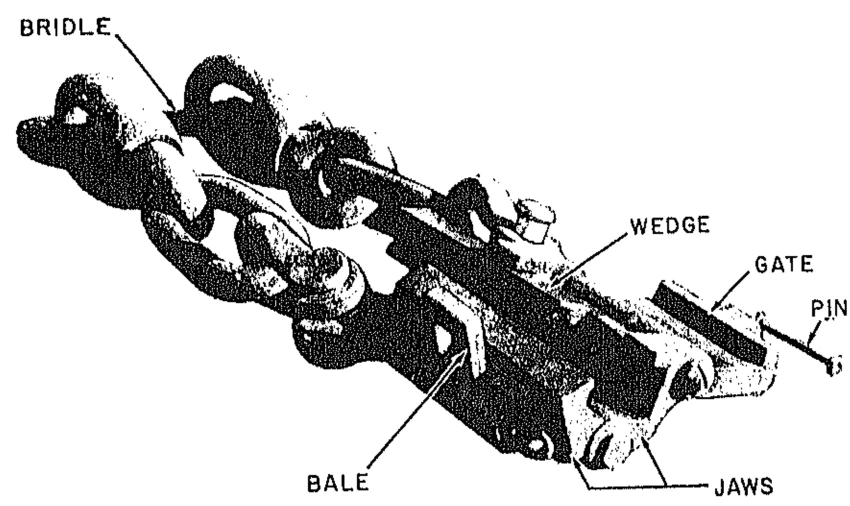

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Figure 7-9.—Carpenter stopper.

assistance. The straight pull method is shown in figure 7-10. However, this type of pulloff is not always effective, in which case wrenching action proves advantageous. The wrenching method is usually augmented by laying out the stranded ship's anchors, one to either quarter at about a 20° angle to the ship's centerline. The tug, using a Liverpool bridle, wrenches the offshore end of the stranded vessel to one side. This rotation of the vessel serves two purposes: First, it breaks the grip of bottom suction. Second, it shortens the distance between forecastle and anchor on the opposite side from the assisting vessel. Slack in the chain is taken in by the stranded vessel and the chain hove taut and secured. The operation is repeated on both sides alternately, using the length of the ship as a lever arm. This action is illustrated in figure 7-11.

Moving the wreck is slow, and little distance is gained in the beginning. But ships hard aground have been moved by the wrenching method. The

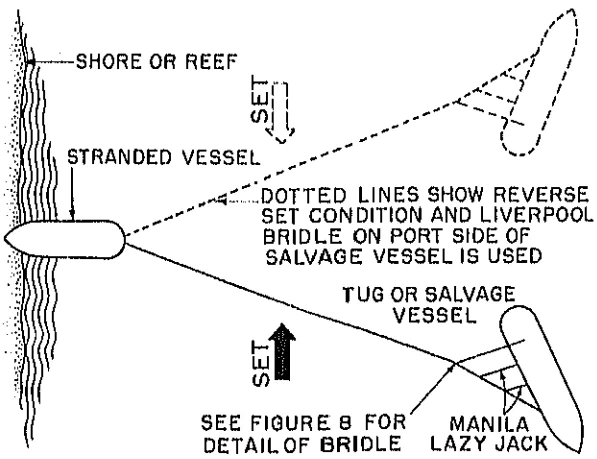

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Figure 7-10.—Straight pull method with a Liverpool bridle.

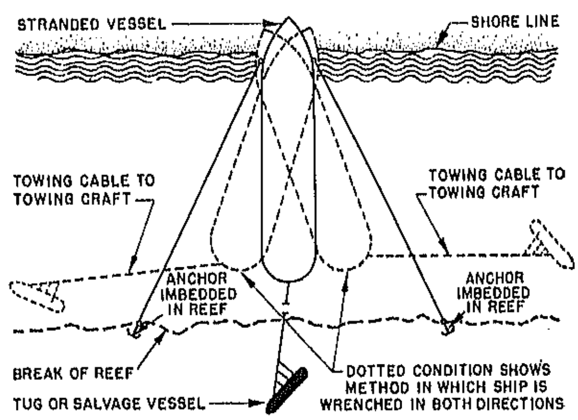

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Figure 7-11.—Wrenching operation.

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Figure 7-12.—Eells anchor.

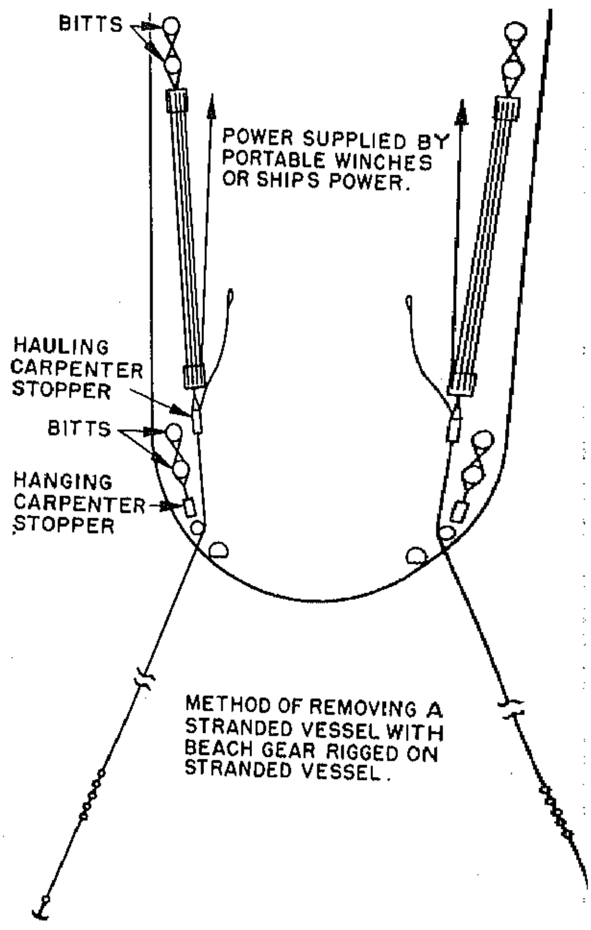

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Figure 7-13.—Beach gear rigged on a stranded vessel

tug should be ready at all times to tow the vessel clear of the beach when it is pulled free.

BEACH GEAR. Beach gear provides the most effective force that can be used for refloating stranded vessels. In general, it consists of a complicated arrangement of anchors laid out offshore and connected to the stranded vessel by strong wire cables. The ship's winches can obtain a heavy strain on the wires by using purchase gear. A beach gear layout is composed of a number of individual sets of gear. Deck space available on the stranded vessel for purchase gear layout is the only limiting factor to the total number of sets that can be used.

One of the most important phases of using beach gear is developing a complete layout plan. This plan is the responsibility of the salvage officer and should include all of the following information: Position of the wreck; soundings in the area; line of direction of each set of beach gear; layout of purchase gear aboard the wreck; pumping plan for flooded spaces; procedure an sequence for casting off beach gear; and a plann course of action after refloating. The layout plan in addition, covers all phases of the pulling operations including wrenching of the vessel before the final heave. The salvage officer must ensure coordination in all phases of the refloating operation.

One stranded set of beach gear contains the following items:

One 8,000-pound Eells-type anchor (figure 7-12)

Two 100-fathom lengths and one 150-fathom length of 1 5/8-inch wire cable with thimbles in each end to fit connecting shackles

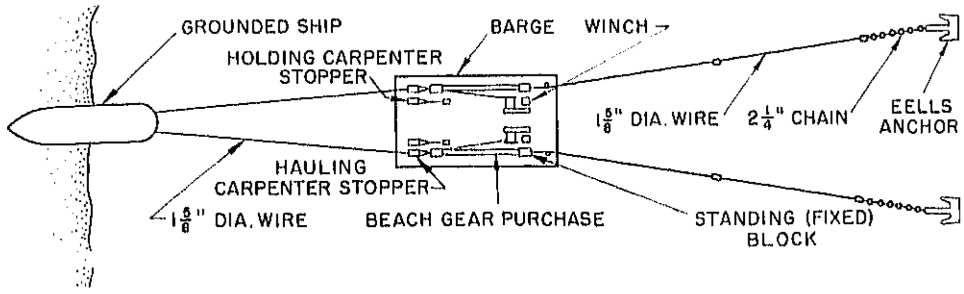

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Figure 7-14.—Beach gear rigged on a barge.

One 15-fathom shot 2 1/4-inch stud-link chain

Four plate-type connecting shackles (3 small and 1 large)

One 5/8-inch wire cable grips (carpenter stoppers) with bridles (figure 7-9)

One heavy purchase gear consisting of:

One standing block (4-sheave)

One running block (4-sheave)

One 1,200-foot length 5/8-inch wire

One fairlead block (for 5/8-inch wire)

One fairlead block (for 1 5/8-inch wire)

One anchor buoy

One 15- to 20-fathom crown line of 8-inch manila or appropriate size synthetic line, or 7/8-inch wire

One winch (7-ton line pull)

Each set is capable of a 50-ton line pull. Figure 7-13 shows two sets of beach gear with the purchase gear rigged on the stranded vessel.

Figure 7-14 illustrates a variation in the use of beach gear. Here we have two sets of beach gear with the purchase gear rigged on a barge. Remember that it is the most effective method to refloat a stranded vessel.

CARRYING OUT AN ANCHOR

Most stranding cases entail carrying out one or more anchors. This is one of the first protective actions a stranded vessel must take to avoid being driven harder aground or broaching. The method by which this action is accomplished depends on the circumstances. Carrying out an anchor by tug presents fewer difficulties. But, more often than not, a tug is not immediately available and a stranded vessel must use other means to lay out its anchor(s)—usually small boats.

CARRYING OUT AN ANCHOR BY TUG

There is no set method of carrying out an anchor by tug. What system you use will depend on your vessel's arrangement and your own ingenuity as a Boatswain's Mate. A suggested method is to hand it off on a wire strap as shown in figure 7-15.

The safe working load of 1 1/4-inch wire is 12,600 pounds, and in this rig you have two parts. Notice that a timber or large fender is placed under the strap to protect the tug's railing. The anchor can be tripped at any time by knocking away the ring on the pelican hook. The seaman who trips the pelican hook must keep well to one side to avoid the hook's whip. The round turn on the bitts should keep the strap from going over with the anchor.

Ordinarily, a large anchor is not carried out on its own chain. Instead, the chain is broken at

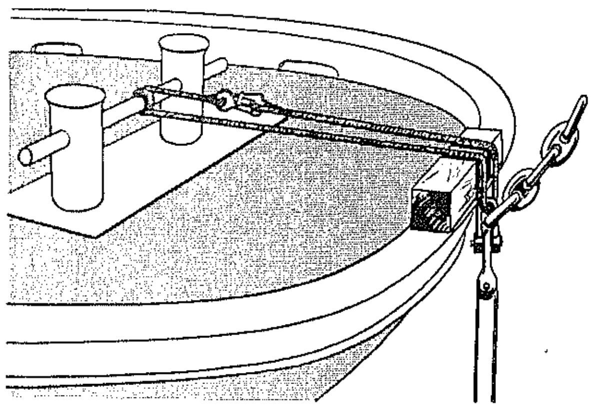

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Figure 7-15.—Hanging off an anchor on a tug.

one of the connecting links and a heavy wire bent on. If the chain is carried out, it is faked down on the tug's fantail under the strap as illustrated in figure 7-16. Seizing used to lash the chain to the tug's bitts should be small enough to part and allow each section of the cain to run out in turn. Ample chafing gear should be used to minimize damage to the tug. When wire is used, it is faked down and lashed in the same manner as chain. This prevents the wire from fouling when the anchor is let go.

CARRYING OUT AN ANCHOR BY SMALL BOAT

A small boat can be used to carry out an anchor by various methods. Regardless of the method used, one prime factor to remember is that the weight of the anchor must never exceed the maximum allowed cargo load of the boat(s). Such data will be listed on the label plate in your boat. A single boat can carry under its keel an anchor equal in weight to its maximum allowed cargo load. Two similar boats can carry between them an anchor whose weight is twice the allowed load of either boat. However, a boat carrying an anchor over the stern must be ballasted forward for trim. If the anchor is carried in this manner, it must be no heavier than one-half the boat's maximum allowed cargo load.

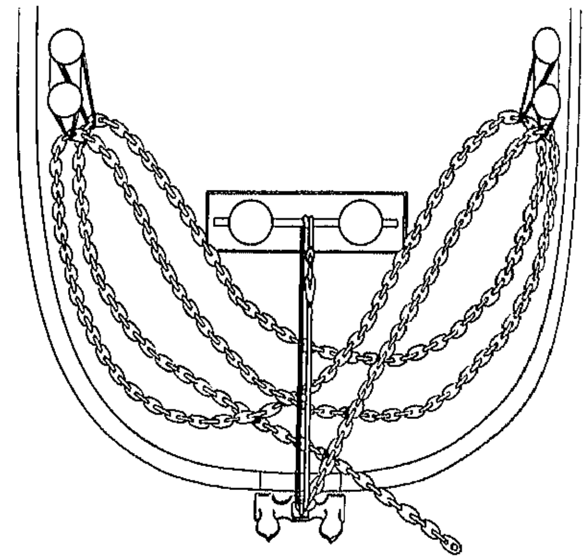

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Figure 7-16.—Faking down and lashing chain.

OVER A BOAT'S STERN.—One convenient way to carry out an anchor is to hang it off a boat's stern. However, you are restricted to amphibious-type craft such as LCM, LCVP, etc. A motor whaleboat or motor launch is not adaptable to this operation because of vulnerable rudder location. The simplest rig is a wire strap pelican hook arrangement similar to that shown in figure 7-15. On a boat, however, the strap would be in a horizontal plane with a round turn around each sternpost. The pelican hook should be secured with a preventer to check any dangerous whip when the anchor is let go. Manila/synthetic line of the necessary strength may be used if no strap is available. Cut the line when you wish to drop the anchor. In both cases, ensure there is adequate chafing gear between the anchor and the boat's stern to prevent damage to the boat.

Carrying out an anchor on its own chain in a boat or boats is out of the question because of weight and difficulty in handling. The hauling line in this case will always be either manila/synthetic or wire. If manila/synthetic, it may be payed out from the ship as the boat stands away. A considerable length of line should be coiled down in

the boat, ready to be thrown over as the point is approached where the anchor is to be dropped. By throwing over this part of the line last gives freedom of control to the boat.

With a line, it is better in some cases to coil the whole length of the line in the boat and carry it out with the anchor. The line is payed out as the boat returns to ship after letting go. This is a good method to bear in mind if the anchor has to be carried out during adverse weather conditions. Another point to remember is that a boat with an anchor hung out maneuvers with difficulty, because propulsion and rudder effect are sluggish. A good plan is to use a free boat to tow the anchor boat to its desired location. The anchor boat also may be hauled out by a line to a kedge anchor located beyond where the main anchor is to be planted.

Wire-hauling line is more difficult to handle than manila/synthetic. The best way is for the ship to retain the wire and pay out slack as the boat proceeds to the anchor drop point. Weight of a long scope of wire may require that an assisting boat be used to hold up the bight.

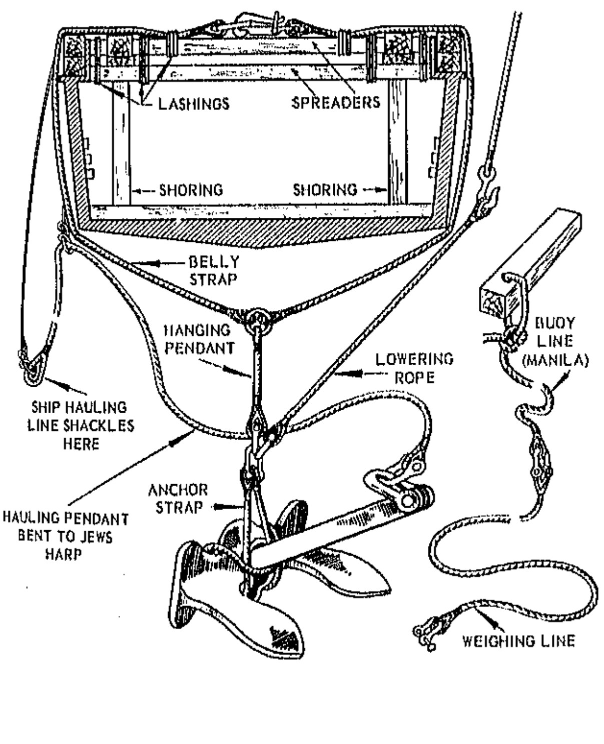

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Figure 7-17.—Carrying out an anchor under a boat's keel.

UNDER A BOAT'S KEEL.—A single boat can carry out a larger anchor by hanging it on a belly strap under its keel than by any other method. However, this method has several disadvantages: It requires advance preparations; the rigging process is involved; and storm conditions would render this method hazardous to personnel and destructive to material.

One method of rigging an anchor under a boat's keel is shown in figure 7-17.

Notice that a spreader is required to relieve strain on the sides of the boat. The spreader is shored up for a heavy anchor but may rest on the gunwales for a lesser weight.

For safety, lash the spreader to a thwart and seize the belly strap temporarily to the spreader. These seizings are cut before letting go.

Placing the anchor strap around the crown causes the anchor to hang conveniently "ring heavy." The hanging pendant must be long enough to reach from the ring under the keel to the water's edge, where it is shackled to the anchor strap when the anchor is lowered from the ship. The lowering rope pendant must also be long enough to be available from the boat. It is uncoupled when the anchor is hung off, and a weighing line is shackled to it in place of the line or wire which lowered the anchor from the ship. The weighing line is bent to a buoy so that it will be available on the surface when the time comes to recover the anchor.

A hauling line may be bent to the ring of the anchor, but if the ship's hauling line is heavy wire, it is better to shackle a hauling pendant to the ring as shown in figure 7-17. The pendant must be long enough to reach the surface after the anchor has hit bottom. It should be buoyed, permitting the ship's hauling wire to be sent out later and shackled to the pendant.

There is a variation to the above procedure which is more suitable in shallow water. About the only difference is that the hanging pendant slides on the bight of the belly strap. The hanging pendant, in that case, can be made much shorter, as it can be slid up the belly strap to the water's edge or above. The pendant need be only long enough to permit being shackled to the eyes of the anchor strap. Once shackled on, the eye of the pendant slides down as the anchor is lowered away, until it hands off under the keel.

A disadvantage of this procedure is that in a heavy seaway the anchor may slide on the belly strap as the boat rolls. To prevent that from happening, if heavy rolling is expected, preventer lines must be rigged from the gunwales to the hanging pendant.

BETWEEN TWO BOATS.—Carrying out an anchor between two boats is the only feasible method to use with a very heavy anchor. Furthermore, this method is the safest if the anchor's weight approaches the working load of a single boat. The procedure used in handling the anchor is substantially the same as for other methods described. There is one essential difference: The anchor is handled by the ring with the weighing line bent independently to the crown.

The anchor is hung off on two spars rigged between two boats as shown in figure 7-18. The spars are securely lashed to thwarts and kept apart by a pair of heavy timbers placed between them. The hanging pendant is attached to a pelican hook secured by a wire strap to the after spar. The pendant runs from the pelican hook over the forward spar as shown. You must take a round turn on this spar before connecting the anchor to the hanging pendant. Without the round turn, the spar acts as a sheave and strain on the spar becomes approximately double the weight of the anchor.

Stand well clear when you trip the pelican hook to release the anchor, as there is always a dangerous whip. The whip can be minimized by making the slipping end of the pendant as short as possible.

WEIGHING ANCHOR BY BOAT

The simplest way to recover an anchor is to run a line from the ship to the end of the weighing line and use a ship's winch or windlass to drag the anchor home, crown first. If the anchor cannot be recovered in this manner, it must be weighed by a boat.

The boat brings the weighing line in over its stern and applies a tackle to it, rigged from forward. A strain is taken on the tackle, and the flotation of the boat is used to lift the anchor. One way to use this buoyant power is to settle the stern by crowding personnel aft, take up hard on the tackle, and then sally all hands forward. It is necessary to lift the anchor only high enough to permit its being carried back to the ship.

If there is no weighing line to the crown, the anchor must be broken out by the ring. Under these circumstances it is seldom possible for a boat to break out an anchor heavier than 3,000 pounds.

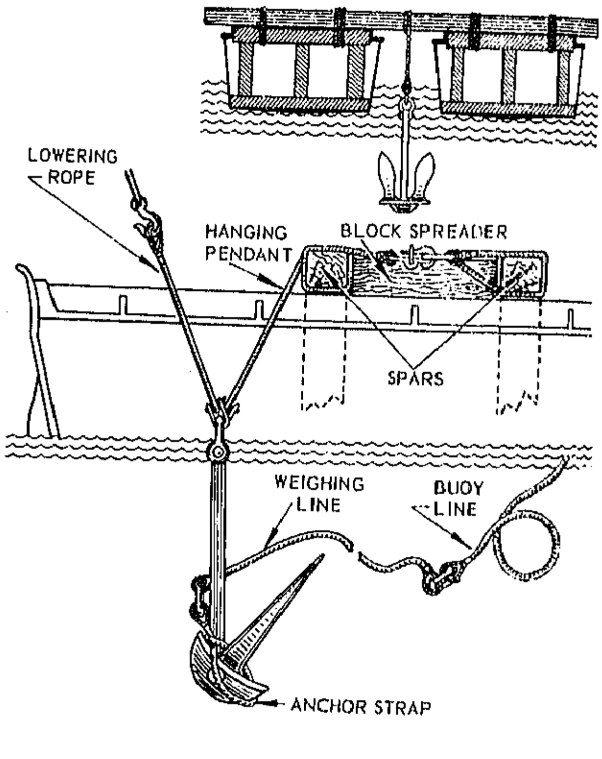

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Figure 7-18.—Carrying out an anchor between two boats.

CHAPTER 8

SHIPHANDLING

Boatswain's Mates First Class and Chief Boatswain's Mates are often designated tug captains or placed in charge of barges or other yard and district craft. Also, on some large seagoing ships, they are designated by the commanding officer to stand junior officer of the deck watches. Aboard smaller ships they may even stand officer of the deck watches. Assignment to such duties is a serious responsibility.

That you have been given such responsibility is an expression of the commanding officer's confidence in your alertness, professional knowledge, and ability. If the CO were not certain you could handle such an assignment competently, the safety of the ship would not be placed in your hands. For your part, you should accept this responsibility eagerly and demonstrate by your performance that this trust has not been misplaced.

It is true, of course, that complete knowledge of shiphandling can be gained only through experience. Anyone who is familiar with the principles of shiphandling and knows how and why the ship reacts under certain circumstances is in a position to put that experience to best advantage.

Many of the craft to which Boatswain's Mates are assigned are the single-screw type. This discussion of shiphandling will, therefore, be confined to maneuvering characteristics of the single-screw ship. Should you be assigned a ship which has twin screws, you are that much better off. By making use of both engines on a twin-screw ship, you are able to maneuver in smaller spaces than you could with a single-screw vessel.

Before you ever do any practical shiphandling, however, it is mandatory that you have a thorough knowledge of the Rules of the Road and piloting.

PHYSICAL CHARACTERISTICS OF YOUR SHIP

As a new skipper, you should be enthusiastic about your billet and you should be interested in discovering everything you can about your ship. You should know more about your ship than anyone else on board. Of course, most of the details in which you as a new skipper would be interested (such as material condition, personnel, logs, and records, etc.) are not too closely allied to shiphandling. You will find a wealth of material, however, in the ship's blueprints, ship's characteristic cards, damage control books, etc. You will probably make an inspection of the ship from keel to masthead and from stem to stern. When you do, take the ship's blueprints along. They will help you in getting oriented.

Some of the factors you must ascertain follow.

1. DIMENSIONS. Length and beam are important factors in shiphandling in confined waters, and in assuring yourself that an assigned berth is of the required size. The height of your mast also is important, for it may be necessary to unship it prior to going alongside a large vessel with an overhang or beneath a low bridge.

2. DRAFT AT VARIOUS LOADINGS. Draft, of course, will determine the minimum depth of water you may safely navigate.

3. CARGO AND PASSENGER CAPACITY. For cargo, this information is necessary to ensure that your vessel is not overloaded; that it is full and down but with no list, sagging, or hogging; and that it has the desired trim and stability. Passenger capacity for your ship type is determined by higher authority based on the adequacy of messing and berthing facilities.

4. MAIN ENGINES.

a. CAPABILITY. This includes maximum speed, best cruising speed, economical cruising speed, maximum backing power, and maximum propeller line pull. Also, know the time and power required to stop your vessel from any given speed. Acceleration and deceleration time rates in tabular form should be available for your use on the bridge.

b. ENGINE CONTROLS. You should have accurate knowledge of the location and operation of all types of engine controls and all means of communication between yourself, as conning officer, and engineroom personnel.

c. LOGISTICS. Know the capacities of your various fuel tanks—crude, diesel, gasoline, or any combination which may be installed. This is vital in determining cruising radius and in damage control or preparing for heavy weather when you may have to ballast or shift fuel.

5. RUDDER. The turning effect of the rudder at various angles will determine the sea room you will require when maneuvering by rudder alone in confined waters or in formation. We will discuss that in the next section.

You can learn a lot by skillfully questioning the skipper you are relieving. Of particular interest are any characteristics of the ship which are a departure from the norm, such as unusual wind or current effect, critical speeds (speeds at which severe vibration is experienced), and poor backing power.

MANEUVERING CHARACTERISTICS

Before delving into the mechanics of shiphandling, first learn the forces which act on the ship under various speed and rudder angle conditions. A shiphandler, if aware of these forces, can compensate for the undesired effects and use the helpful effects to best advantage. Without knowledge of these forces, shiphandling at best would be a trial-and-error procedure.

FORCE FACTORS

It is beyond the scope of this training manual to treat hydrodynamic principles. Experts are not in complete agreement among themselves why the forces created by propeller and rudder react on the ship as they do. They do agree, however, that the forces so generated are the result of pressure differences. How do these pressure differences occur?

For all practical purposes, water is incompressible. If force is applied to water (thereby causing high pressure), the water will flow to a lower pressure area, producing a force known as dynamic pressure.

In the case of a ship, high- and low-pressure areas are created by the propeller and the rudder. As the propeller revolves to go forward, the shape and pitch of each blade develops a thrust derived from a low-pressure area on the forward face of the blades, and a high-pressure area on the after face of the blades. The force set up by this displacement of water is transmitted along the propeller shaft to thrust the ship ahead or astern, as the ship moves in the direction toward the low-pressure area. That is known as propeller thrust.

The rudder exerts its force in a somewhat similar fashion. When the rudder is set at an angle on a moving ship, a high-pressure area is built up on the leading surface, while a low-pressure area forms on the trailing surface. Thus the water, through this difference in pressure areas, exerts a force against the leading surface of the rudder which in turn forces the stern in the direction opposite that to which the rudder is set. This is known as rudder force.

Before discussing screw-rudder combinations and how they affect the ship, additional force factors must be understood.

Side Force

In maneuvering a single-screw ship, side force ranks next in importance to propeller thrust. Side force might be defined as a force which moves (walks) the stern of the ship in the direction of propeller rotation. Side force is at its maximum when the ship is dead in the water and decreases rapidly with an increase in ship's speed.

Frictional Wake Current

A vessel moving through the water will drag some of the water along due to friction between the skin of the ship and the water. That is called frictional wake current. Frictional wake current at the waterline is zero at the bow and increases to maximum at the stern. It is also maximum at the waterline and decreases with depth toward the keel. The degree of frictional wake increases proportionately to ship's speed and is greatest in shallow water. It is to counteract the effect of skin friction that the underwater hulls of ships are streamlined.

Frictional wake current causes a loss in propeller efficiency because the propeller has to work in this wake. For example, if a ship is moving at 10 knots and has a following wake of 2 knots near the propeller, the propeller would be advancing at only 8 knots relative to the water. Frictional wake current also decreases the effect of side force.

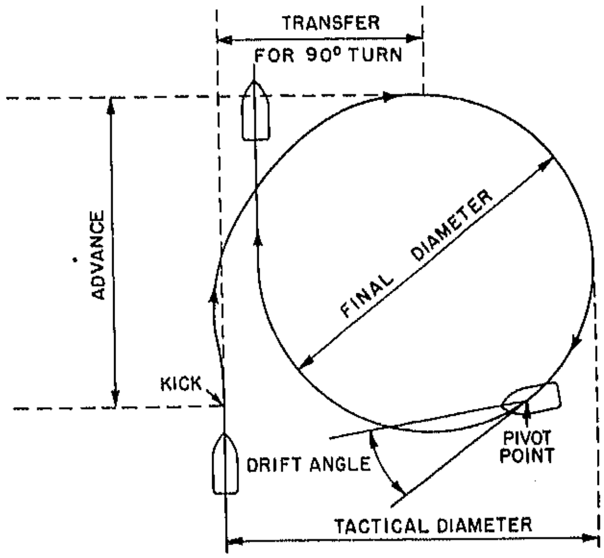

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Figure 8-1.—Turning circle.

Screw Current

Screw current, caused by the action of a rotating propeller, consists of two parts. The portion flowing into the propeller is the suction current, and the portion flowing away from the propeller is the discharge current. Suction current is a relatively minor force in shiphandling. Discharge current is a major force in two main respects: (1) It is a strong force acting on the rudder with the screw going ahead, and (2) it is a strong component of side force when the screw is backing because of the part of the discharge current which acts against the ship's counter.

TURNING CIRCLE

A ship's turning circle is the path described by the ship in completing a full 360° turn with a constant rudder angle. (See figure 8-1.) High speed also has noticeable effect on turning circle, the amount of change depending upon the ratio of speed to the square root of the length of the ship. The greater the ratio, the greater the diameter of the turning circle. Small changes in speed, however, do not significantly alter the diameter. Consequently, the distance covered during a 360° turn is fairly constant, but the time required to make the turn will vary with the ship's speed.

The following definitions relate to various aspects of the turning circle.

1. ADVANCE. Distance gained toward the direction of the original course after the rudder is put over.
2. TRANSFER. Distance gained at right angles to the original course when turning. Figure 8-1 shows transfer for a 90° turn. For a 180° turn, transfer equals tactical diameter.
3. TACTICAL DIAMETER. Perpendicular distance between the path of the ship on the original course and the path of the ship when a 180° turn has been completed with a constant rudder angle. The standard tactical diameter is prescribed in current tactical orders. It is important that the rudder angle to obtain this diameter be known by the conning officer.
4. STANDARD RUDDER. Rudder angle necessary to turn ship in the prescribed tactical diameter.
5. FINAL DIAMETER. Diameter of the circle which ultimately will be scribed by a ship that continues to circle with a constant rudder angle.

6. DRIFT ANGLE. Angle at any point on the turning circle between the intersection of the tangent at that point and the ship's keel line.

7. KICK. Swirl of water toward the inside of the turn when the rudder is put over. Also, the momentary movement of the ship's stern toward the side opposite the direction of turn.

8. PIVOTING POINT. Point on the centerline about which the ship pivots when the rudder is put over, or the point of the ship upon which it turns and which scribes the turning circle.

When the rudder is put over in making a turn, the stern is forced away from the direction of the turn. For several lengths, the ship turns very slowly from its original course because of momentum. It then begins to gain ground in the new direction, moving sidewise through the water to a considerable degree. This naturally results in loss of speed and is why, when a column turn is made, a vessel gains rapidly on the ship ahead while that ship is turning, but loses this distance during its own turn when the first ship completes its turn and steadies on the new course.

A ship's pivoting point is nearly always about one-third the ship's length abaft the bow when moving ahead, and at or near the stern when moving astern. The location of the pivoting point will also vary with ship's speed, an increase in speed shifting the pivoting point in the direction of the ship's movement. In close waters the conning officer must always bear in mind the position of the pivot point before starting a turn. This is especially important when moving ahead to prevent the stern from swinging in to an undesirable location.

RUDDER EFFECT

Basically, a ship's rudder is used to attain or maintain a desired heading. The force necessary to accomplish this is created by dynamic pressure against the flat surface of the rudder. The magnitude of this force and the direction and degree to which it is applied produces the rudder effect which controls stern movement and, through it, the ship's heading. Factors having a bearing on rudder effect are rudder size, rudder angle, headway, sternway, propeller direction, suction current, discharge current, side force, etc. As you can see, the degree of each factor and the possible combinations are infinite.

FUNDAMENTALS OF SHIPHANDLING

To better understand the effect of various rudder and screw combinations upon the ship, assume that ideal shiphandling conditions exist; that is, no wind, no current, no tide, plenty of sea room, with no interference from other vessels. You are conning a YO with a single rudder and single right-handed screw (turns clockwise going ahead).

Going Ahead

In going ahead from a stopped position, the first noticeable effect is that the ship's stern will swing to starboard because of side force. Right rudder is applied to counteract this swing, the necessary force being obtained from the discharge current against the rudder surface. As the ship gathers headway due to propeller thrust, the ship will reach a speed where the wake current will overcome side force to a great extent and right rudder may be removed. Now the ship will continue straight and will respond equally well to either left or right rudder. Rudder effect is obtained from the action against the rudder surface of both the dynamic pressure of the discharge current and the pressure of the water through which the ship is moving.

With the ship going ahead at a good speed, suppose you want to stop. The screw is backed. The propeller thrust will be in direct opposition to the forward motion of the ship, causing the ship to start slowing. Side force and part of the discharge current will tend to force the stern to port. This can be compensated for by left rudder as long as the ship has sufficient forward motion to retain steering effect. As forward motion is reduced further, steering effect is reduced to zero, and side force and that part of the discharge current acting against the ship's counter will cause the stern to swing to port. This can be partially compensated for by shifting to right rudder to take advantage of the force of the suction screw current acting against the rudder surface.

Backing Down

Backing down in a straight line with a single-screw ship is virtually impossible without alternating the direction of the screw and the position of the rudder. Let's see why that is so. In going

astern from a stopped position, the stern will swing to port because of side force and a portion of the discharge current. That cannot be counteracted, even with full right rudder, as the suction current acting against the rudder surface is a relatively weak force. As the ship gathers sternway, the water through which the ship is moving acts against the rudder surface, augmenting the force of the suction current. That will slow, but probably not stop, the stern's continued swing to port. The best way to straighten out is to go ahead on your screw and, as the discharge current builds up, shift your rudder to left full. Then you will have two forces working to stop the port swing and bring the ship to the proper heading: side force, and discharge current acting against the rudder surface. When the heading of the ship is satisfactory, continue the backing procedure as used initially.

Casting

The situation often arises where you must alter the heading of your ship radically without allowing any appreciable change in its initial position. That is known as casting. Casting is also referred to as "turning short," "twisting ship," "turning it on its pivot point," etc. These all mean the same thing. The rudder-screw combination you use depends on which direction you choose to turn your ship. The shortest arc of turn is the simplest and quickest. The key to that maneuver is to apply all the forces available to start the stern swinging before the ship gathers headway or sternway. If you wish to pivot the ship to a heading on the port side, go ahead on your screw with full left rudder. Side force and discharge current acting against the rudder surface will force the stern to swing rapidly to starboard before propeller thrust imparts forward motion to the ship. When the ship starts to gain headway, back the screw and shift the rudder. Side force from the backing screw will slow the stern's swing. That is unavoidable. To remain in the ship's initial area, you must take way off the ship. When forward motion has been stopped completely, go ahead on your screw and shift your rudder to left full. Repeat these screw-rudder combinations until the ship is on the desired heading.

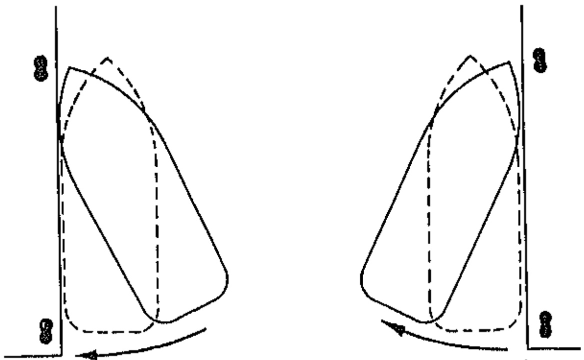

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Figure 8-2.—Effect of side force when backing.

A pivot to starboard is accomplished by a different sequence of screw-rudder combinations. That is, you start the maneuver by backing the screw with full left rudder. Side force and the suction current against the rudder surface will start the stern swinging rapidly to port. As the ship gathers sternway, shift your rudder and go ahead on your screw. Repeat these screw-rudder combinations until the ship is on the desired heading. With a single-screw ship, it is easier and quicker to cast to starboard than to port. That can be easily understood if you will again consider propeller effect.

Going Alongside

In the foregoing section, the theory of handling a single screw ship using various rudder-screw combinations was presented. Now you should have a pretty good idea of what to expect of the ship under the ideal conditions specified. Now let's consider some of the more common shiphandling situations you will encounter, such as going alongside.

PORT-SIDE-TO.—Figure 8-2 illustrates that it is always easier to bring a single-screw craft alongside port-side-to than starboard-side-to. That is because when you have eased your bow in alongside your berth and back down to kill headway, the side force of the backing screw will swing your stern in alongside the berth.

STARBOARD-SIDE-TO.—In a starboard-side-to landing, side force will swing your stern away from the berth when you back down. Consequently you must make your approach for a starboard-side-to landing at slow speed to avoid having to back hard to kill headway. Another disadvantage of a starboard-side-to landing engendered by the slow approach is that the less headway you have, the less will be the steering effect of your rudder, thus making the ship harder to control.

Wind and Current

You often can make use of what may at first appear to be adverse conditions of wind and current. That is where the art of shiphandling enters the picture. Plan your maneuver so that all the known factors are taken into account. The Navy says nothing about the loss of a few minutes, but is highly critical of unnecessary damage to ships and installations resulting from lack of planning or poor judgment.

CURRENT FROM AHEAD.—If you have plenty of room and there is a fairly strong current from ahead, ease your bow alongside and get out the forward bow spring line. The current will bring you in to the dock, as shown in the first view of figure 8-3.

CURRENT FROM AFT.—When the current is from aft, putting out the after quarter spring line (second view in figure 8-3) will produce the same result. Going alongside with a current from aft is more difficult, however, because the following current makes rudder effect very erratic.

USING CURRENT ONLY.—Going alongside by means of the current alone is not practical unless you have plenty of room to range ahead or astern. Often your berth will be restricted in size, so that you will have no room to move ahead. This situation is no particular threat when the current is from ahead; but, in easing your stern alongside, you will have to use your screw and rudder carefully. A following current in an approach to a small berth is much more serious, not only because of the lessened steering effect of your rudder but also because side force from the backing screw combines with the current to swing your stern away from the berth. A stern line is imperative in this case, and you may possibly need outside assistance.

Most single-screw ships maneuvering into a short berth prepare the No. 2 line (after bow spring) on the dock side and get its eye out to the dock as soon as possible (figure 8-4). It is belayed on the No. 2 bitts on board and carefully checked until headway is stopped. Care must be

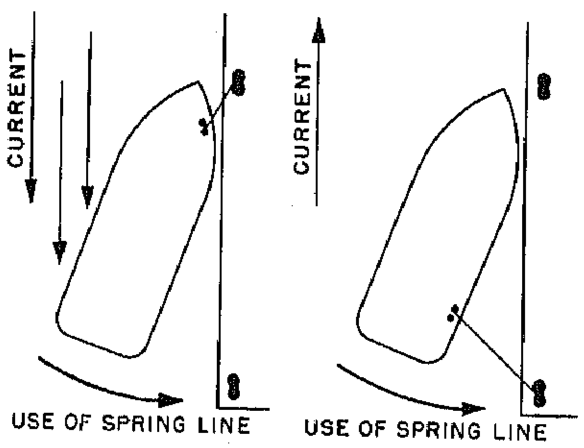

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Figure 8-3.—Making use of current.

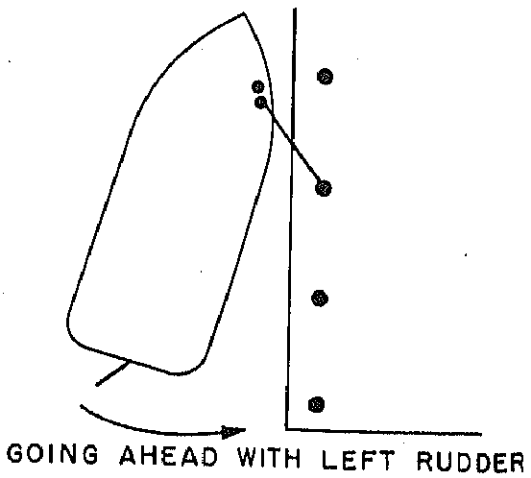

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Figure 8-4.—Use of spring line.

taken to avoid parting the spring at this point. If there is too much headway, the screw will have to be backed to save the spring. But don't forget, that will force your stern farther off a starboard-side-to berth.

Wind Effect

Wind effect is another element that you will have to contend with when going alongside. Wind is generally erratic in velocity, so allow yourself a greater safety margin. Remember that the bow and stern may not be equal in sail area, and wind effect on the ship as a whole will not be distributed uniformly. Another consideration is that, when approaching the lee side of a berth or another vessel, wind effect at the bow is reduced greatly while wind effect on the stern continues to act with full force. As in the case of current, you can take advantage of the wind if it is blowing toward your berth. Make your approach so as to stop farther out from your berth than in a no-wind situation, and let the wind bring you in alongside. You probably will have to make some use of your screw and rudder to keep the ship parallel to the berth.

When the wind is setting you off your berth, the situation is more difficult. For a port-side-to landing, approach the pier at a greater angle than normally used and with slightly more headway. Get your bow line out to hold the bow, and use side force of the backing screw to bring the stern in. To make a starboard-side-to landing, with the wind setting you off your berth, again approach the pier at a greater angle than normally used and with slightly more headway. Get your bow line and No. 4 (after quarter spring) line out. By going ahead slowly on your screw with full left rudder, side force, rudder effect, and the No. 4 line acting as a spring, your stern will be forced in against the wind. In that situation, experienced shiphandlers may drop the port anchor to hold the bow. Should you wish to use this method, always check your chart first to ensure that you are not prohibited from dropping an anchor in that area.

GETTING AWAY FROM A BERTH

The next operation to consider is getting underway. Again, take your time and evaluate existing conditions; then plan your line of action. Wind effect should be apparent to you from the bridge. Current effect is more difficult to judge. If you are moored in a slip, current effect in the immediate vicinity of your ship may be completely different from that out in the stream. Throw a block of wood over the side and note how it is affected by the current. That will give you an approximate idea what to expect from current action.

Starboard-Side-To Berth

When possible, the best way to clear a starboard-side-to berth is to back with left rudder. Side force and suction current on the rudder will swing your stern out from the berth so that you can back clear safely. If there is no room astern, you can move your stern out from the dock by using No. 2 line as a spring and going ahead slow with full right rudder.

Port-Side-To Berth

Trying to back away from a port-side-to landing, however, will tend to send your stern against the dock. The best procedure for getting away in this case is to leave your No. 2 (after bow spring) line out and go ahead with hard left rudder until the stern is clear. Then take in the No. 2 and back. The left rudder and the lever effect of No. 2 will bring the stern far enough out for you to get away, at the same time restricting the forward motion of the ship. When alongside another ship or a sea or river wall, regardless of side, you can usually throw your rudder to the opposite side and simply back down. You must depend on bank cushion and suction to get your stern out and to keep you from scraping the ship or wall. (See topic on bank cushion and suction.)

Current from Ahead

With a strong current running from ahead, you could probably clear either-side-to by slacking your head line and letting the current send the bow off. Once it is well off, let go all lines and go out ahead, but don't forget that when you have put your rudder away from the pier, your stern will swing in that direction as you go ahead,

especially when you are leaving a starboard-side-to landing. Be careful not to use too much rudder until you are well clear.

Current from Aft

With a current from aft, slacking the stern lines will carry the stern off in the same manner. If you are lucky enough to be in a set direction off the pier, all you have to do is let go all lines and let the current carry the ship broadside out into the stream.

BANK CUSHION AND SUCTION

Two other factors you must be aware of are bank cushion and bank suction.

With a ship going close and generally parallel to a bank, sea wall, or another ship, bank cushion forces the bow out and suction pulls the stern in. These forces are easily understood if you consider how the bow funnels the water into a narrowing area and how the screws suck in water from ahead and discharge it astern.

When backing down, the effect is reversed. Discharge current from the screws builds up a cushion at the stern. The stern goes out and the bow in.

When going ahead, bank cushion and suction can be counteracted by intelligent use of the rudder. Going astern, however, a combination of speed and rudder is required.

SINGLE-SCREW PECULIARITIES

The preceding sections on shiphandling can do no more than give you an idea of some well-known idiosyncrasies of single-screw vessels. This training manual cannot go into detail concerning unusual circumstances wherein a ship will act in a noncharacteristic manner. For instance, the tendency of a long, light craft with a high freeboard to back into the wind may offset its tendency to back to port. Habits peculiar to your particular ship must be learned from your predecessor and from experience.

OFFICER OF THE DECK

The commanding officer designates as office of the deck those line officers on board who are considered qualified to relieve each other standing watches as ship supervisors and administrators of ship routine. Marine Corps officers below the rank of major may be assigned also as OODs in port. The Marine Corps officers on the junior watch list may stand JOOD watches at sea.

The officer of the deck is the officer on watch in charge of the ship and is responsible for its safety, subject to any orders received from the commanding officer. Every officer or other person on board, regardless of rank, subject to the orders of the commanding officer, is subordinate to the officer of the deck (except the executive officer) and the command duty officer, when assigned.

As a Chief Boatswain's Mate you must become qualified to stand a junior officer of the deck watch, for a large number of ships to which you may be assigned utilize senior petty officers in this capacity. You may even be assigned as OOD in a smaller vessel. In either assignment, you must be thoroughly acquainted with the duties and responsibilities of the OOD. The purpose of this section is to familiarize you with these duties and responsibilities.

STANDARD COMMANDS

As OOD or JOOD you should issue orders "in the customary phraseology of the service."

Commands to the helmsman should be delivered in a tone of voice loud enough that there will be no question about hearing you. Commands should also be given in the following order:

1. Right (or left)—to indicate in which direction the rudder is to be moved.
2. Standard (or 5°, 10°, 15°, etc.)—to inform the steersman of the rudder angle desired.
3. Rudder.

A standard command to the helmsman in the proper sequence would therefore be:

Right   10 degrees   rudder.

Require that the helmsman repeat the command to you exactly as you have given it. That

will ensure you that there is no misunderstanding and that the helmsman knows what to do in response to your command.

Similarly, commands to the engine order telegraph operator should be clear and distinct and should be given in a certain sequence, namely:

1. All engines (starboard engine) (port engine)—indicates to the operator which engine or engines the command is intended for.
2. Ahead (back)—indicates direction desired.
3. Full (one-third) (two-thirds, etc.)—indicates power desired.

Therefore, a standard command to the engine order telegraph operator would be:

Port engine back one-third.

An additional factor in commands to the engineroom is in adjusting speed to meet your needs. That becomes necessary on most occasions at sea and is accomplished by regulating the number of revolutions on your propeller(s). The proper commands are:

1. Indicate (ring up) 91 (etc.) revolutions.
2. Indicate turns for 11 (etc.) knots.

Again, as in the case of the helmsman, require that the command be repeated to you exactly as you have given it.

Your best single source of information on the subject of standard commands is the *Watch Officer's Guide*, published by the Naval Institute Press. It is the recognized handbook for guiding OODs in the proper performance of their duties.

THE DECK LOG

The deck log contains a complete chronological record of the ship's history from the time first commissioned to the day the commission pennant comes down and the ship's active career is terminated. It presents a complete, accurate narrative of noteworthy incidents in the life of the ship and of events affecting its officers, crew, and passengers.

Besides its historical importance, the log has legal standing. It may be required to be produced in naval, admiralty, or civil courts. When, as is frequently the case, witnesses to an incident involving a ship or its crew or passengers are dead or widely dispersed, the log may be the only available evidence upon which important legal decisions may be rendered. For that reason, entries must be absolutely clear, concise, and accurate.

OPNAVINST 3120.32 relative to the deck log, reads as follows.

> *The deck log shall be a complete daily record, by watches, in which shall be described every circumstance and occurrence of importance or interest which concerns the crew and the operation and safety of the ship or which may be of historical value. The deck log shall include, as appropriate, data and information regarding:*
>
> *1. Orders under which the ship is operating, and the character of duty in which engaged*
> *2. Significant changes in the state of the sea and weather*
> *3. Courses and speeds of the ship*
> *4. Bearings and distances of objects detected*
> *5. Position of the ship*
> *6. Tactical formation of the ships in company*
> *7. Draft*
> *8. Soundings*
> *9. Zone description*
> *10. Particulars of anchoring and mooring*
> *11. Changes in the status of ship's personnel or passengers except for the recording of receipts and transfers of officers by reason of permanent changes of station and except for the recording of receipts and transfers of enlisted personnel*
> *12. Damage or accident to the ship, its equipage, or cargo*
> *13. Death or injuries to personnel, passengers, visitors, longshoremen, harborworkers, or repairmen*
> *14. Meeting and adjourning or recessing of courts-martial and other formal boards*

15. Arrests, suspensions, and restorations to duty

16. Such other matters as may be specified by competent authority.

The deck log shall be prepared in the manner and form prescribed by the Chief of Naval Operations.

Ships may be exempt from recording entries in the deck log daily by watches only under the following circumstances:

1. The Chief of Naval Operations, through the fleet or force commander, may direct that the deck log for ships engaged in special operations, whose operations are recorded through means other than the deck log, be limited to the nonoperational data required by the preceding paragraph and the entries be made upon occurrence of noteworthy events rather than daily by watches. The operational data for ships so directed shall be recorded in the manner prescribed by the Chief of Naval Operations.

2. Ships undergoing a scheduled period of regular overhaul, conversion, or inactivation may, during that period, make log entries upon occurrence of noteworthy events rather than daily watches.

RELIEVING THE WATCH

To become acquainted with the situation before assuming responsibility, the relieving OOD should arrive on the bridge at least 15 minutes before the watch begins. An officer about to relieve the deck must be thoroughly familiar with the position of the ship in relation to vessels in sight, and with reference to any nearby land, shoals, or rocks. He or she must determine the general condition of the weather, ship's course and speed, main engines and boilers in use, all unexecuted orders, special orders of the commanding officer, or night orders, condition of the running lights and other appliances required by law to prevent collisions, condition of the force on deck available for duty, and the general condition of the ship. When the ship is in formation, the OOD must ascertain, before relieving, that it is in proper station. If the ship is out of station, the OOD may decline to relieve until that fact has been reported to the commanding officer.

The OOD may also decline to relieve if the watch is not yet up and ready for duty. If the ship is in a perilous position, the OOD may decline to relieve until that fact has been reported to the commanding officer or other competent authority. Further, should the OOD feel physically unfit to assume or to continue the watch, he or she should report to the senior watch officer and request to be relieved.

The OOD should not relieve the watch until a complete picture of the situation has been obtained and the following information received from the officer being relieved is understood.

1. Tactical information:

a. Type formation, axis, course, and speed.

b. Location of all ships by station number and, if in column, whether own ship is odd or even.

c. Identity and location of guide. Own ship's position coordinates.

d. True, gyro, and magnetic course.

e. Standard speed and reserve speed available.

f. Screen type and axis.

g. Zigzag plan.

h. Station keeping data.

i. Condition of readiness.

j. Condition of radars and other equipment and any limitations on their use.

k. Any unexecuted tactical signals.

l. Tactical publications available.

m. Course, speed, and closest point of approach of any contacts not in own formation.

2. Navigational information:

a. Position of ship (fix or DR) on the chart.

b. Land and any aids to navigation in sight or expected to be sighted.

c. Condition of electronic navigation equipment and whether in use.

d. Present weather conditions and any expected change.

e. Current being experienced or expected, and any unusual hydrographic conditions.

3. Ship information:

a. Which officer has the conn.

b. Material condition of readiness set.

c. Status of lookouts, sea details, watch on deck, and leadsman (if required).

d. Ready lifeboat and lifebuoys.

e. Condition of ground tackle, air ports, ventilators, watertight doors, etc.

f. Location of commanding officer, operations officer, navigator, and flag officer (if any).

g. Drills, exercises, or ship's word scheduled during the watch.

h. Boilers and machinery in use and those out of commission (if any).

i. Status of prisoners.

j. Any standing or unexecuted orders. A relieving OOD at night must read and initial the captain's night order book.

PREPARATIONS FOR GETTING UNDERWAY

A typical checkoff list from the *Standard Organization and Regulations of the U.S. Navy* gives you an idea of the duties of the OOD in getting underway. In general, the OOD must—

1. Notify department heads. Obtain a muster report.

2. Order the word passed, "All hands make preparations for getting underway at (time)"!

3. Order the word passed, "Set material condition Yoke modified"! (or appropriate condition).

4. Ascertain that all boats and mail orderlies have returned or have been notified to return to the ship. Make the general recall signal if necessary.

5. Order boats hoisted in, last boat to be aboard about 15 minutes before getting underway. Permission to pick up last boat should be obtained from the executive officer.

6. Station the special sea detail 30 minutes before getting underway. Order word passed for all hands to shift into uniform of the day.

7. Order boat booms and gangways rigged in and secured for sea.

8. Ascertain that the senior quartermaster tests the steering gear, engine room telegraph, telephone circuits, etc. Obtain permission from the commanding officer to test main engines. Obtain from the navigator information on the state, velocity, and direction of the tide.

9. Ascertain that all department heads have made readiness for getting underway reports 20 minutes before sailing time.

10. Shift from quarterdeck to bridge.

11. Check the number of boilers in use.

12. Report immediately any delay in getting underway to the executive officer or commanding officer. Report readiness for getting underway to both officers.

13. If at night, ascertain that searchlights are manned and ready for use.

When a ship prepares to get underway, UNIFORM flag is displayed on the appropriate side, depending on the anchor in use. While heaving in the anchor, UNIFORM is at the dip. When the anchor is aweigh, UNIFORM is close up. UNIFORM is hauled down when the ship is ready to proceed.

RESPONSIBILITY UNDERWAY

When at sea, and especially when approaching land or in pilot water, the officer of the deck must keep informed of the position of the ship, whether land or lights are in sight or likely to be seen, and of all other particulars which may be useful in keeping the ship out of danger. If approaching land or shoals, leadsmen must be kept in the chains and the anchors clear and ready for letting go. The OOD must remain in charge until regularly relieved, and must not engage in any occupation which may distract his or her attention from duty.

In addition, the OOD must see that the watch is at all times alert, at their stations and ready for duty, and that every necessary precaution is taken to prevent accidents. The OOD ascertains that a boat is always ready for lowering and life buoys ready for letting go, that the lookouts are on

station and vigilant, and that they understand their duties. The OOD must exercise great care that the ship is kept on its course, and must keep correct account of the course, speed, and headway made good. The OOD ensures that running lights are kept bright from sunset to sunrise and their condition reported every half hour; that during a fog, when approaching vessels, and at all other times when collision is possible, precautions required by law to prevent collisions are fully complied with. In pilot waters, the OOD makes sure that nothing is placed near the compass which will change its error, and that a leadsman is stationed in the chains ready to take depth soundings in the event of Fathometer failure.

When in company with other ships, the OOD keeps accurate station. If unable to do so, the fact must be reported to the commanding officer at once. Except for minor changes to maintain station or an emergency to avoid immediate danger, the OOD must not change course, alter speed, or perform any important evolution without consulting the commanding officer. However, advice from the navigator is sufficient authority to change course, but the change must be reported at once to the commanding officer.

The OOD promptly reports to the commanding officer all land, shoals, rocks, lighthouses, beacons, buoys, discolored water, vessels, or wrecks sighted. Also, the commanding officer is notified immediately of all signals made, changes in formation, course, speed, or axis ordered by the officer in tactical command and independent movements of ships in company. Further, the OOD keeps the commanding officer informed of all weather changes—such as marked change in the barometer, force or direction of the wind, state of the sea, visibility—and any noticeable indication of bad weather. The OOD reports the hours of 0800, 1200, and 2000 meridian time to the commanding officer and flag officer (if embarked) and at these times submits the navigator's position report. In addition, at 1200 the OOD reports the winding and comparing of chronometers, and submits the chief engineer's fuel and water report.

In time of war, or when hostilities may be expected, the OOD must not make any dispositions that interfere with immediate use of the armament. If at any time a suspicious ship or other object is sighted that possibly may have a hostile purpose, the OOD must instantly make preparations for battle and inform the commanding officer.

Except to warn ships of immediate danger the OOD does not make any official signal, either by day or night, without authority from the commanding officer. The OOD sees to it that a good lookout is kept for signals, that none is answered until understood, and that authorized appliances for making signals of all kinds are at hand and ready for use night and day. The OOD directs that all signals and official messages sent or received (oral included) are recorded immediately, noting the time and the vessel(s) or station to or from which the signal is made. When there is danger of collision, the OOD must at once sound the signals for closing watertight doors.

At sunset and at the beginning of each watch the OOD receives from the coxswain of the ready lifeboat the report on the boat's condition of readiness. Further, the OOD sees to it that the MAA, petty officer of the guard, corporal of the guard, security watch, or other person detailed for that purpose makes the rounds of the ship, visiting all accessible parts below the main deck every half hour between 2200 and reveille. During these rounds the MAA, petty officer, or corporal of the guard is to inspect the lights, prisoners, and watch, for irregularities of any kind, reporting results to the OOD. The latter may also direct the junior officer of the deck, if any, to make a security check when the JOOD's services on the bridge can be spared.

The officer of the deck directs the carrying out of the daily routine, weather and other circumstances permitting. When the bell or bugle of the flagship or senior ship can be heard, the quartermaster of the watch is directed to follow in striking the bell and in making routine signals.

PASSING HONORS

When any merchant vessel under United States registry, or the registry of a nation formally recognized by the United States Government, salutes a ship of the U.S. Navy by dipping its ensign, such salute must be answered dip for dip. The OOD must keep an eye out for vessels which are going to pass within saluting distance, and ensure that somebody is standing by the ensign to return the dip promptly. It is ridiculous to see someone scrambling frantically to return a salute

while the ship which originally dipped its ensign goes on into the distance unanswered.

Passing honors to foreign war ships and dignitaries, or to officers or officials passing in boats, are rendered in accordance with doctrine contained in *Navy Regulations.*

PREPARATIONS FOR ENTERING PORT

The OOD of a ship entering port directs the following preparations in advance:

1. Notifies the engineroom of the time of anchoring as far in advance as possible. Also notifies the executive and weapons officers, the engineer officer, first lieutenant, boatswain, and gunner.
2. Directs that garbage and other refuse be disposed of as prescribed in current directives.
3. Stations the special sea detail when directed by the commanding officer.
4. Orders boats prepared for lowering, with running lights ready. Orders a boat prepared to make a guard mail trip.
5. Orders ground tackle or mooring lines, as appropriate, for anchoring or mooring.
6. If the ship is going alongside, announces which side, and orders lines, fenders, heaving lines, and line-throwing gun prepared on that side.
7. Orders gangways and booms rigged and prepared for running out.
8. Orders batteries, searchlights, booms, cranes, etc., not in use to be secured in prescribed position for entering port.
9. Orders boat covers, hatch covers, awnings, and other canvas properly stowed, and slack rigging squared away.
10. Orders boatswain's mate of the watch to pipe down all bedding (if necessary), and to see that nothing is hanging over the side or dangling on the lifelines.
11. Orders word passed for crew to shift to uniform of the day. Orders unassigned personnel to quarters reasonably in advance of time of arrival.
12. Directs preparations for rendering honors, as necessary.
13. Stations details at the colors for returning salutes, shifting colors, and hoisting the jack upon anchoring or mooring. If entering port at night, stations detail ready to turn on anchor lights and has a forward searchlight manned for use in piloting.
14. Ascertains that working parties, mail orderlies, and others who are to leave the ship are ready to depart instantly.

OOD IN PORT

Before relieving the watch in port, the OOD obtains information on the following:

1. Anchor in use and scope of chain.
2. Depth of water and type of bottom.
3. Lines in use, if alongside.
4. Anchorage bearings, if at anchor.
5. Weather conditions expected and preparations for same.
6. State of tide.
7. Boiler and auxiliaries in use.
8. Senior officer present afloat and other ships present.
9. Location of flag officer (if any), captain, executive officer, and department heads.
10. Senior officer aboard and senior duty officer.
11. Boats in the water, their location, and boat officers available.
12. Absentee, prisoner, and duty lists.
13. General appearance of the ship.
14. Orders for the day; special orders.
15. Liberty section, time liberty expires, and approximate number of personnel ashore.
16. Guard ships.
17. Status of planes, if any.
18. Work or drills in progress or scheduled.
19. Visitors on board or expected, and any orders concerning same.
20. Workers or other authorized civilians on board.
21. If at night, designated ready lifeboat and any morning orders for the anchor watch.
22. Boat schedule.

To summarize, the OOD is responsible, in general, for—

1. Safety and security of the ship.
2. Safety of personnel, boats, planes, and other material.
3. Readiness of the ship for duty.
4. Smart appearance of ship, boats, and crew.
5. Comfort and contentment of crew.

Honors and Ceremonies

Honors, ceremonies, and the respect due superior rank have an importance in the military service which is sometimes difficult for a civilian to comprehend. Members of the service can understand it better, because they realize that the effectiveness of any military outfit depends to a great extent upon respect for and obedience to higher authority.

The officer of the deck is charged with responsibility for the meticulous observance of all honors. *Navy Regulations* and the *Watch Officer's Guide* describe details of the required action to be taken in the various situations. Keep your memory refreshed by periodic study of these publications.

Side Honors

When a boat approaches a ship, it is essential that the OOD know the rank of the senior person about to board the ship, so that the visitor may be received with ceremonies appropriate to rank. During daylight, a boat carrying a commanding officer flies the national ensign aft; and, if embarked in a boat of the naval service on official occasions, the personal flag, command pennant, or, if not entitled to either, a commission pennant flies in the bow. A miniature of such a flag or pennant may be displayed in the vicinity of the coxswain's station when embarked on other than official occasions in a boat of the naval service. Officers of flag rank making official calls fly their personal pennants forward. The Secretary of Defense, the Secretary of the Navy, the Under Secretary and Assistant Secretary, and the President of the United States, also have personal flags for this purpose. The flagstaffs fore and aft are capped with special insignia conforming to the rank of the senior person in the boat.

A boat approaching a ship at night is hailed from the quarterdeck with "Boat ahoy"! Answering hails by the coxswain indicate the rank of the senior person in the boat as follows:

OFFICER OR OFFICIAL	COXSWAIN'S REPLY
The President or Vice President of the United States.	"UNITED STATES"
Secretary of Defense, Deputy or Assistant Secretary of Defense.	"DEFENSE"
The Secretary, Under Secretary, or Assistant Secretary of the Navy.	"NAVY"
Chief of Naval Operations, Vice Chief of Naval Operations.	"NAVAL OPERATIONS"
Fleet or force commander.	"FLEET" or abbreviation of administrative title
A general officer.	"GENERAL OFFICER"
A chief of staff.	"STAFF"
A flotilla commander.	"________ FLOT ________" (Type) (number)

OFFICER OR OFFICIAL	COXSWAIN'S REPLY
A squadron commander.	"________ RON ________" (Type) (number)
A division commander.	"________ DIV ________" (Type) (number)
A Marine Corps officer commanding a brigade.	"BRIGADE COMMANDER"
A commanding officer of a ship.	"________" (name of ship)
A Marine Corps officer commanding a regiment.	"REGIMENTAL COMMANDER"
Any other commissioned officer.	"AYE, AYE"
Other officers (not commissioned).	"NO, NO"
Enlisted personnel.	"HELLO"
A boat not intending to go alongside, regardless of rank of passenger.	"PASSING"

It is not strictly accurate to say that the answering hail indicates the rank of the senior person on board. The actual rank of some of the individuals mentioned in the table may vary. During daylight you are chiefly interested in knowing how many side boys will be required, and that depends on the actual rank of the person coming aboard. In the case of a flag officer, rank can easily be determined from the number of stars on his or her flag, but a commanding officer or a squadron or flotilla commander does not always have a specific rank.

To simplify the matter of side boys, it has become the custom during daylight for the coxswain of a boat (carrying persons of sufficient rank to rate side boys) to indicate the rank of the senior person in the boat by holding up fingers equal in number to the number of side boys that person rates. In other words, the coxswain of a boat carrying a captain would hold up four fingers to inform the quarterdeck to station four side boys.

CHAPTER 9

NAVIGATION FOR THE BOATSWAIN'S MATE

Navigation is the art and science that enables the mariner to determine the ship's position and guide it safely from one point to another. Because you may be assigned as skipper of a small craft, or be required to stand OOD/JOOD watches on board ship, we will discuss how to determine position and related subjects that will assist you in the safe operation of your vessel.

DETERMINING POSITION

We have four ways of determining position in navigation, every one of which locates a ship's position with relation to some locality or object(s) whose location is already known. These four methods of finding position are—

1. Piloting, in which position is determined by bearings on or distances from visible objects on the Earth's surface, or by soundings.
2. Dead reckoning, in which position is determined through the direction and distance a ship has traveled from a known point of departure.
3. Celestial navigation, in which position is found by locating a ship with relation to the celestial bodies.
4. Electronic navigation, in which position is determined much as it is in piloting except that the bearings and/or distances are obtained by electronic means.

By using any of the foregoing methods of navigation, the ship's position can be kept on charts in the pilothouse.

The four ways of determining position will receive individual treatment as this chapter progresses. Right now we want to discuss some of the fundamentals you must know about objects located on the terrestrial sphere.

TERRESTRIAL SPHERE

Let's say you are looking at a white cue ball with an absolutely blank surface. Take a pencil and make a mark on it. Now, how would you tell anybody where on the cue ball the mark is located? The answer is: You could not. There are no points or objects on the cue ball with reference to which you can locate the mark.

The Earth is a sphere, just as that cue ball is. It is called the terrestrial sphere. Although it is a little flattened at the poles instead of being perfectly spherical, that irregularity is disregarded here for simplicity. Reference points for location of objects on the Earth, with two exceptions, have been established by general agreement among maritime nations. The two exceptions are the North and South Poles, located at the ends of the axis on which the Earth rotates. Imaginary lines (an infinite number of them) running through the poles and around the Earth are called meridians. They divide the Earth into sections, the way an orange is divided into segments.

Now, suppose you start at the North Pole and travel along a meridian exactly halfway to the South Pole. You will then be on the Equator, an imaginary line running around the Earth which bisects every meridian and divides the Earth in half. The half the North Pole is on is called the Northern Hemisphere; the other half, the Southern Hemisphere.

CIRCULAR MEASUREMENT

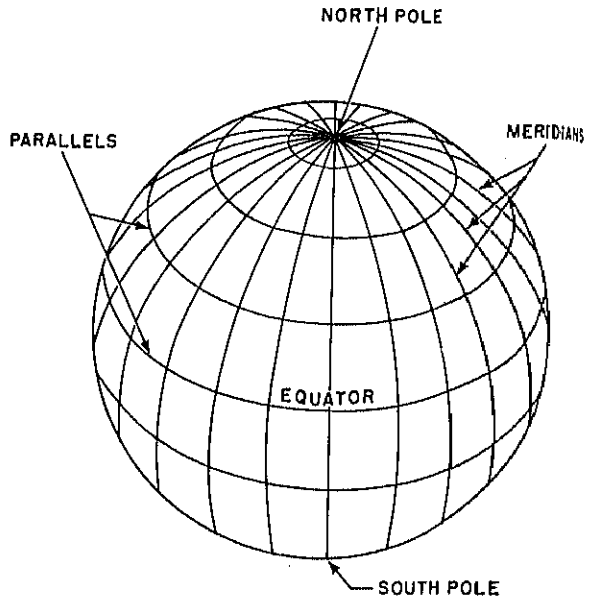
Before going any further, you will have to know something about how distances are measured along the circumference of a circle. Measurement along a meridian, which is a perfect circle, is expressed in degrees of arc. These degrees of arc may be transformed into linear measurement in nautical miles (described later). The best example of circular measurement in degrees of arc is the compass card. Whatever the size of the card, its circumference always contains 360°. Each degree contains 60 minutes (′); each minute, in turn, contains 60 seconds (″). The nautical mile, by arbitrary international agreement, is now 6076.11549 feet or 1852 meters. The nautical mile is about one-seventh again as long as the statute mile.

MERIDIANS AND PARALLELS

So far, in developing a system for locating points on the terrestrial sphere, we have a series of meridians running through the poles around the Earth. A single line, called the Equator, runs around the Earth at right angles to its axis. These reference lines can be seen in figure 9-1. The Equator divides each meridian and the Earth itself into two exact halves.

For every degree around the Earth's rim there is a meridian—360 of them 60′, or 3600″ apart. A starting point for numbering these specific meridians was required, and most of the maritime countries decided that the starting point should be the meridian on which was located the Royal Observatory at Greenwich, England. The Greenwich meridian, then, is number 0, and meridians run from 0 east and west to the 180th on the opposite side of the Earth from Greenwich. The complete circle formed by the 0 and 180th meridians, like the Equator, divides the Earth into two exact halves, one of which is the Eastern and the other the Western Hemisphere. Every meridian runs true north and south.

Let's leave the meridians now, and go back to the Equator. Imagine a globe of the world has been cut in half exactly along the Equator, and the northern half set on the chart table, flat edge



65.116(69)
Figure 9-1.—The terrestrial sphere.

down. Get your eye lined up so that the flat edge appears as a straight line and you will see the upper edge of the shape of a semicircle, containing 180° of arc—90° from Equator to pole on either side.

Beginning with the Equator, you see lines that appear to be parallel to it, one for each of the 90° of arc from the Equator to the North Pole. The planes forming these lines on the Earth's surface are actually parallel to each other, and for that reason they are called parallels. As a matter of fact, if you shift your eye to a point just above the pole, you can see that the lines are actually circles, growing increasingly smaller as they get farther from the Equator and nearer the poles. Remember, no matter how small a circle is, it still contains 360°. The distance represented by each degree becomes less, however, as the parallel circles get smaller.

The starting point for numbering the parallels is the Equator, the 0 parallel. Parallels are numbered from 0° to 90°N and S of the Equator, and every parallel runs true east and west.

Do not get the idea that there are only 360 meridians and 180 parallels. There is a meridian or parallel for every one of the 21,600 minutes around the complete circle of the Earth's sphere. The parallels and meridians are imaginary, but there is a limit to the capacity of our instruments, and we seldom break down measurement along a meridian or parallel to a value smaller than that of a second.

Now we have a network of meridians and parallels all the way around the globe. Every spot on the Earth is located at the point of intersection between a meridian and a parallel. Every point's location is described in terms of its latitude (distance in degrees, minutes, and seconds of arc N or S of the Equator, measured along the point's meridian) and longitude (distance in degrees, minutes, and seconds of arc E or W of 0 meridian, measured along the point's parallel). Longitude is always from 0° to 180°. Latitude never is greater than 90°. Zero latitude is the Equator. If you are on latitude 90°N, you are at the North Pole, and whichever way you look is south.

GREAT CIRCLE

The concept of the great circle is sometimes difficult for a beginner to grasp, but it is a fundamental that must be clearly understood. A great circle is any circle whose plane passes through the center of the Earth or any other sphere.

What does that statement mean, exactly? Suppose you have a perfect sphere of soft rubber through which you can pass a flat sheet of thin metal. If you shove the metal sheet through the sphere so as to cut it exactly in half, you have passed it through the center. The circumference of the flat side of each half becomes a great circle whose circumference is the same size as the circumference of the sphere itself.

On the other hand, if you shove the flat metal through the sphere so that it does not pass through its center, the circumference of the flat side of each part is smaller than the outside circumference of the sphere.

In both examples cited, the flat sheet represents the plane of the circle the sheet makes when it cuts the sphere. Now, imagine we cut the Earth with a similar plane. No matter how we slice it, if the plane passes through the Earth's center, the cutoff circle is a great circle. If the plane passes through the Earth away from the center, the circle it cuts is a small circle.

The Equator is a circle whose plane passes through the Earth's center; consequently, the Equator is a great circle, and it is the only parallel that is a great circle. The other parallels N and S of the Equator are all small circles whose planes do not pass through the Earth's center. All meridians, on the other hand, pass through the poles, and all of their planes must, therefore, pass through the Earth's center. Consequently, every meridian is a great circle.

Don't get the idea that a great circle must be either a meridian or a parallel. A great circle is any circle around the Earth whose plane passes through the Earth's center, no matter in what direction the plane passes.

The practical significance of the great circle in navigation is this: The shortest distance between two points on the Earth (or on any other sphere, for that matter) is along the great circle passing through the points.

DISTANCE

We have already mentioned the nautical mile. It is equal to approximately 1′ of arc along the Equator, the equivalent in length of about 1-1/7 statute or land miles. The Equator is a great circle; therefore, if 1′ of arc along the Equator is 1 nautical mile, 1′ of arc along any great circle must also be 1 nautical mile. All great circles on the Earth are the same length.

How does this relationship work, then? It means that on any chart the meridians may be used as a distance scale. All meridians are great circles; therefore, 1′ of latitude along any meridian equals 1 nautical mile. On the other hand, when it comes to parallels, 1′ equals 1 mile only along the Equator, the only parallel that is a great circle. To put it another way, 1′ of longitude equals 1 mile only along the Equator.

SPEED

Speed is defined as the time rate of movement and in navigation is usually measured in knots. Knots is a speed term meaning nautical miles per hour. A knot is used as a unit of measurement in expressing the rate of speed of ships and airplanes and in expressing the relative strength of water currents and the degree of intensity of air currents. The time element is included in the definition of knot; therefore, the use of the term "knots per hour" is both redundant and incorrect.

DIRECTION

Nautical direction usually is measured from true north on the observer's meridian.

On the old-fashioned compass card, direction was indicated by points. There were 32 major points around the card, each of which had a name: N, N by E, NNE, NE by N, NE, and so on. Each point was subdivided into quarter points, and the system of naming the divisions toward or away from the points themselves was quite complicated and difficult to remember.

Navigators have long since adopted the system of circular measurement (360° of arc) as a much more convenient means of indicating direction than the ancient system of points. (See figure 9-2.) In the Navy, even relative bearings, formerly expressed as "4 points on the bow," "2 points abaft the beam," etc., are now given in terms of their corresponding degrees. There are 11-1/4° in each of the old-style compass points.

Direction in modern navigation, then, is always given in degrees, measured clockwise from true north, 000°T. A course or bearing, as you know, is always expressed in three figures, regardless of whether three digits are necessary. In other words, it is not 45° but 045°. Seldom is it possible to consider compass direction to a value smaller than the 10th of a degree even though each degree of direction contains 60 minutes of 60 seconds each. As a matter of fact, it is almost impossible to read a compass bearing or heading to closer than a quarter of a degree.

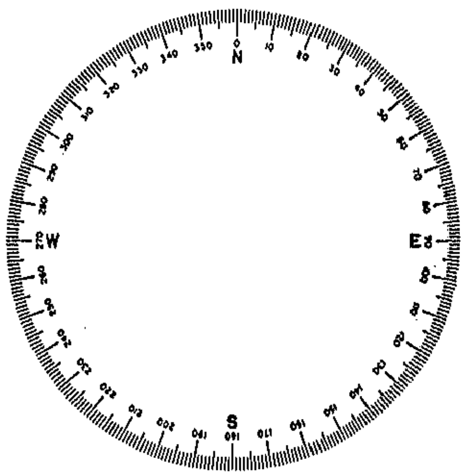


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Figure 9-2.—Degrees on the compass card.

A true bearing is the direction of an object from the observer, measured clockwise from true north.

A compass bearing is the direction of an object as indicated by magnetic compass. It must be converted into a true bearing by applying the corrections for variation and deviation.

A relative bearing is the direction of an object from the observer, measured clockwise from the ship's head, as indicated by the lubber's line in the binnacle, pelorus, or gyro repeater.

There will be times when you will find it necessary to convert from true to relative bearings and vice versa. This relationship is shown in figure 9-3. Note that dead ahead is 000°, dead astern is 180°, and the starboard and port midpoints (beams) are 090° and 270° respectively.

The reciprocal of any bearing is its opposite; that is, the point of degree on the opposite side of the compass card from the bearing. For example, the reciprocal of 180° is 000° and vice versa. When you obtain a bearing on some object, the bearing from the object to you is the reciprocal of the bearing from you to the object. To find the reciprocal of any bearing expressed in degrees, simply add 180° to the bearing. If the

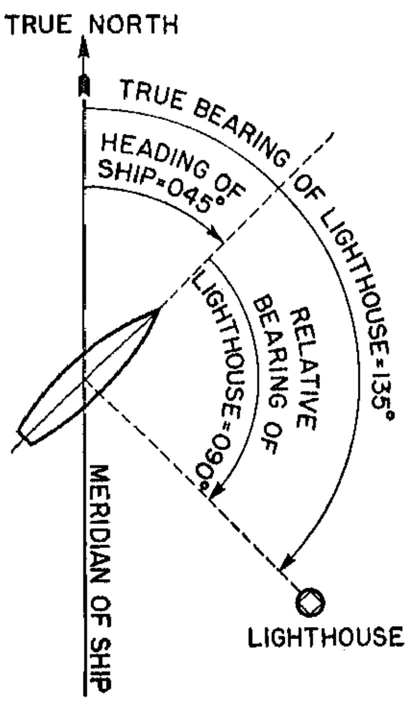

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Figure 9-3.—True and relative bearings.

bearing is 050°, for instance, its reciprocal is 050° plus 180°, or 230°. If your bearing is greater than 180°, subtract 180°.

DEAD RECKONING

Dead reckoning, as stated previously, is the method of navigation by which position is determined by means of the direction and distance traveled from a known point of departure.

A ship underway is moving through water, which is a very unstable element. It might leave point A, steer an exact course according to the true bearing between point A and point B, and still wind up a long distance from B, depending on how much leeway it makes. Likewise, estimating the distance traveled seldom produces an exact result.

The dead-reckoning (DR) position is only an estimated position, calculated from values that rarely are exact. A fix, on the other hand, is a relatively exact location derived from the intersection of two or more lines of position. A DR position is not a fix, but it is calculated from the last fix obtained. In piloting, a fix is obtained by bearings taken on objects whose locations are charted. In celestial navigation, position (fix) is determined by observations of the heavenly bodies. When a ship out of sight of land is prevented by bad weather from taking celestial observations, it must navigate by other means. Normally, electronic navigation is used when the ship is located in an area where it is available. If nothing else can be used, the ship must navigate by dead reckoning.

PLOTTING DR TRACK

In early sailing days, a "dead log" was one of the methods used to measure ship's speed. This means of measuring speed consisted merely of timing the interval between which a piece of wood tossed overboard at the bow was off the stern. Because ship's length was already known, it was a matter of simple calculation to estimate its speed.

Following a ship's dead-reckoning (DR) track from one fix to the next is a continuous process while underway. A constant check on its approximate position is valuable to the navigator in many respects. For celestial observations, for instance, it enables the navigator to locate the ship's assumed position reasonably close to its actual position.

How is the DR track plotted? Suppose that a fix, determined at 0900 by celestial observation, piloting, or electronic navigation, located your ship in latitude 32°42'N, longitude 46°15'W. It is your last fix, and your DR track begins at this point. Which way does it run? The answer is, naturally, along the line of the true course steered. Assume that your course is 055°T. You simply set the parallel rulers or protractor on 055° and shift them to the fix, then draw a line from the fix bearing 055°T. As long as you stay on that course, your DR track will advance along this line. Suppose you are steaming at 20 knots. In 1 hour, or at 1000, your DR position will be 20 nautical miles from the 0900 fix, along the 055° course line.

The line bearing 055° from the fix is the course line or rhumb line. Label it "C 055" above the line, and "S 20" (for a 20-knot speed) below the line. Label the fix 0900 and the DR position at 1000.

The 1000 DR represents where you will be if you travel exactly 20 nautical miles on C 055°; that is, if you are not set to either side of the DR track. If you have a strong headwind or head sea against the bow, chances are that you will not quite make 20 nautical miles. Although the helmsman may keep the ship on exactly 055°T for every second of the hour, it is probable that a wind, current, or a combination of the two elements will work to set it to one side of the course. For this reason, it is most unlikely for the DR position to coincide with the actual position, even after steaming only 1 hour.

In the preceding section we mentioned that you can locate a ship's DR position on the course line by figuring the nautical miles traveled in the time underway since the last fix. In simpler terms, this explanation means that distance traveled by a ship, in nautical miles, equals its speed in knots multiplied by its time underway.

One method of measuring the approximate speed of a ship is by counting the revolutions per minute made by its engines. The speed produced by various revolutions per minute has been calculated already, normally by repeated running of a measured distance at various revolutions per minute. Speed by revolutions per minute is an approximation. A ship forcing its way against a swift current, with its engines turning flank speed, would actually make less headway than if the ship were running with the stream, its engines making the same revolutions per minute.

Another way of measuring speed is by a seagoing speedometer called an underwater log. Three general types of logs are installed in Navy ships: the pitot-static (differential pressure) type, the propeller (electromechanical) type, and the electromagnetic type.

In all three types of logs, a rodmeter (called a sword) protrudes through the hull of the ship beneath the keel and furnishes the speed signal to a mechanism within the ship that converts the signal into speed and distance traveled. In shallow or foul water, the sword must be retracted and housed in its shaft because the slightest scraping can damage the sword and render it inoperable. The electromagnetic log is the most accurate of the three types and it is normally used throughout the fleet.

ELECTROMAGNETIC LOG

The electromagnetic log consists essentially of a rodmeter, an amplifier, an indicator-transmitter, and associated repeaters. The rodmeter contains an electromagnetic sensing element which produces a voltage directly proportionate to the ship's speed through the water. This voltage is amplified and converted to pointer indications of speed on the dial of the indicator-transmitter. The speed and distance signals are transmitted to indicators (figure 9-4) located in the pilothouse, charthouse, CIC, and other ship control stations.

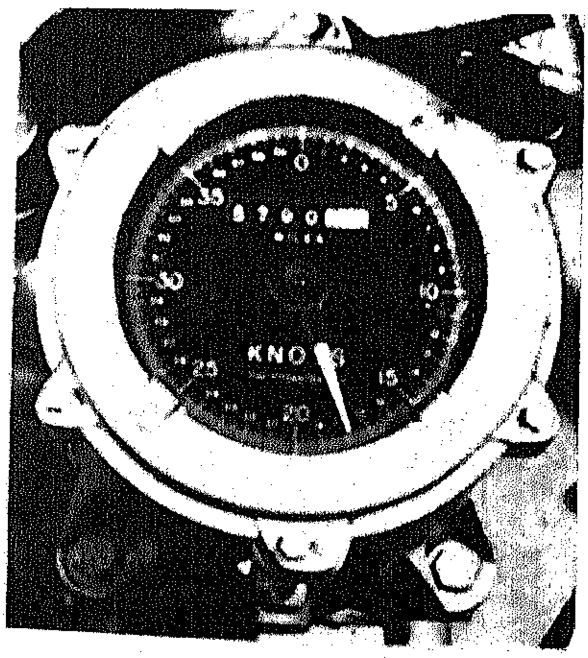

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Figure 9-4.—Underwater log indicator.

:TUAL SPEED

Generally speaking, both the engine revolu-ıns and the log are indicators only of speed ·ough the water. The actual speed over the ɔund cannot be determined unless wind and rrent are taken into consideration.

PILOTING

Piloting is a method of determining position d directing the movements of a vessel by ference to landmarks, navigational aids, or undings. Ordinarily, piloting is used as a imary means of navigation when entering or ıving port and in coastal navigation. It may be ed at sea when the bottom contour makes it ıssible to establish a fix. In piloting, the vigator obtains warnings of danger, fixes the ısition frequently and accurately, and deter-ines the proper course of immediate action.

NES OF POSITION

Piloting entails the use of two or more lines position whose intersection marks the ship's position. A line of position is determined with reference to a landmark. To be useful for this purpose, a landmark must be identified easily, and its position must be shown on the chart in use. Lines of position (figure 9-5) are of three general types: ranges, bearings, and distance arcs.

Two instruments used in taking bearings are the bearing circle and telescopic alidade. A bearing circle is a nonmagnetic metal ring equipped with sighting devices. It is fitted over a gyro repeater or a magnetic compass. Only bearings of objects on the Earth's surface normally are taken with the bearing circle.

Let us assume you want to take a bearing on a lighthouse. First, install the bearing circle on the gyro repeater or magnetic compass, and make sure the vanes rotate freely. Next, line up the vanes in such a manner that, when you look through the opening in the near vane, you see the lighthouse directly behind the vertical wire in the far vane. You then read the lighthouse bearing on the prism at the base of the far vane.

A telescopic alidade (figure 9-6) is a telescope equipped with crosshair, level vial, polarizing

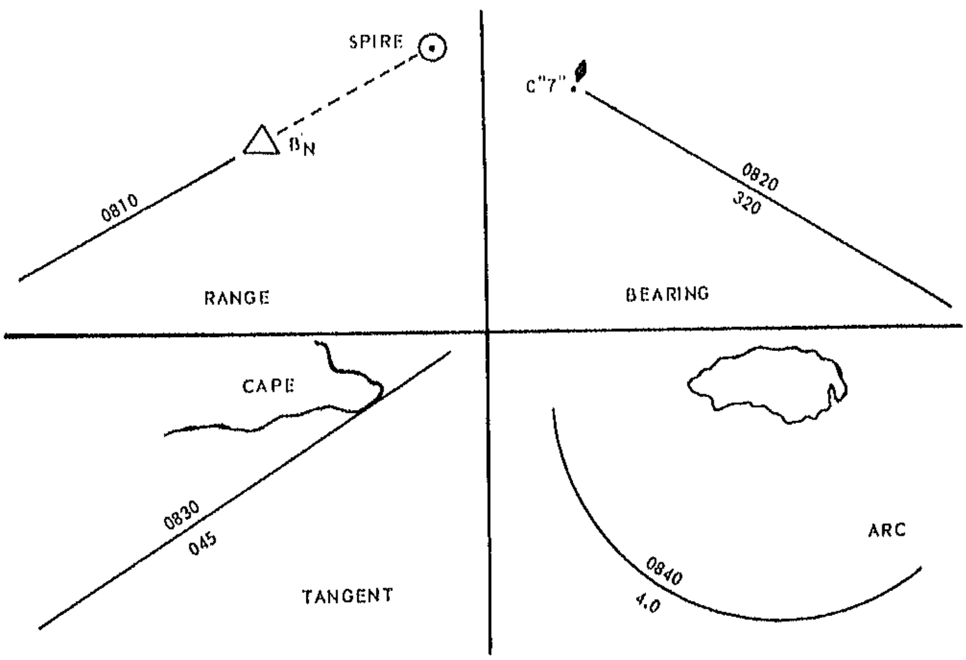

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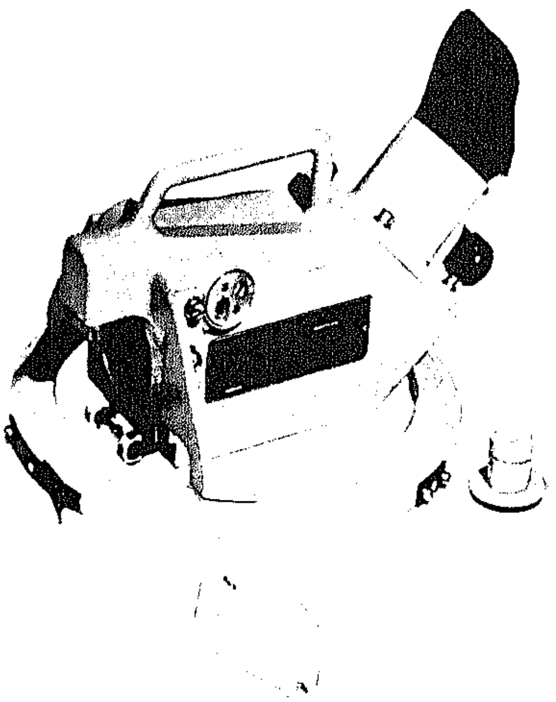
Figure 9-5.—Lines of position.



45.39(69)A
Figure 9-6.—Telescopic alidade.

light filter, and internal focusing. The telescope is mounted on a ring that fits on a gyro repeater or magnetic compass. The optical system simultaneously projects an image of approximately 25° of the compass card, together with a view of the level vial, onto the optical axis of the telescope. By this means, both the object and its bearing can be viewed at the same time through the alidade eyepiece. Older models of the telescopic alidade have a straight-through eyepiece telescope, whereas the model shown in figure 9-6 has the eyepiece inclined at an angle for viewing ease.

Ranges

A ship is said to be on the range when two landmarks are observed in line. This range is represented on a chart by a straight line through two appropriate chart symbols. The line is labeled with the time expressed in four digits above the line. Note that "range" in this c differs significantly from "range" m distance.

Bearing

It is preferable to plot true bearings, although either true or magnetic bearings may be plotted. If a relative bearing of a landmark is observed, it should be converted to true bearing by adding ship's true heading. In plotting, therefore, because bearing indicates the direction of a terrestrial object from the observer, a line of position is drawn from the landmark in a reciprocal direction. If a lighthouse bears 040°, for example, then the ship bears 220° from the lighthouse. A bearing line of position is labeled with the time expressed in four digits above the line.

A special type of bearing is the tangent. When a bearing is observed on the right edge of a projection of land, the bearing is a right tangent. Similarly, a bearing on the left edge of a projection of land, as viewed by the observer, is a left tangent. A tangent provides an accurate line of position if the point of land is sufficiently abrupt to provide a definite point for measurement; it is inaccurate when the slope is so gradual that the point for measurement moves horizontally with the rise and fall of the tide.

Distance Arcs

A distance arc is a circular line of position. When the distance from an observer to a landmark is known, the observer's position is on the circle, with the landmark as center, having a radius equal to the measured distance. The entire circle need not be drawn because, in practice, the navigator normally knows the position nearly enough that drawing an arc of a circle suffices. The arc is labeled with the time above expressed in four digits. The distance to a landmark may be measured by using radar, stadimeter, or sextant, in conjunction with table 9 of the *American Practical Navigator*.

The Fisk-type stadimeter (figure 9-7) is used most frequently to measure distance from your ship to others in a formation. In piloting, it also is used as a navigational aid as, for example,

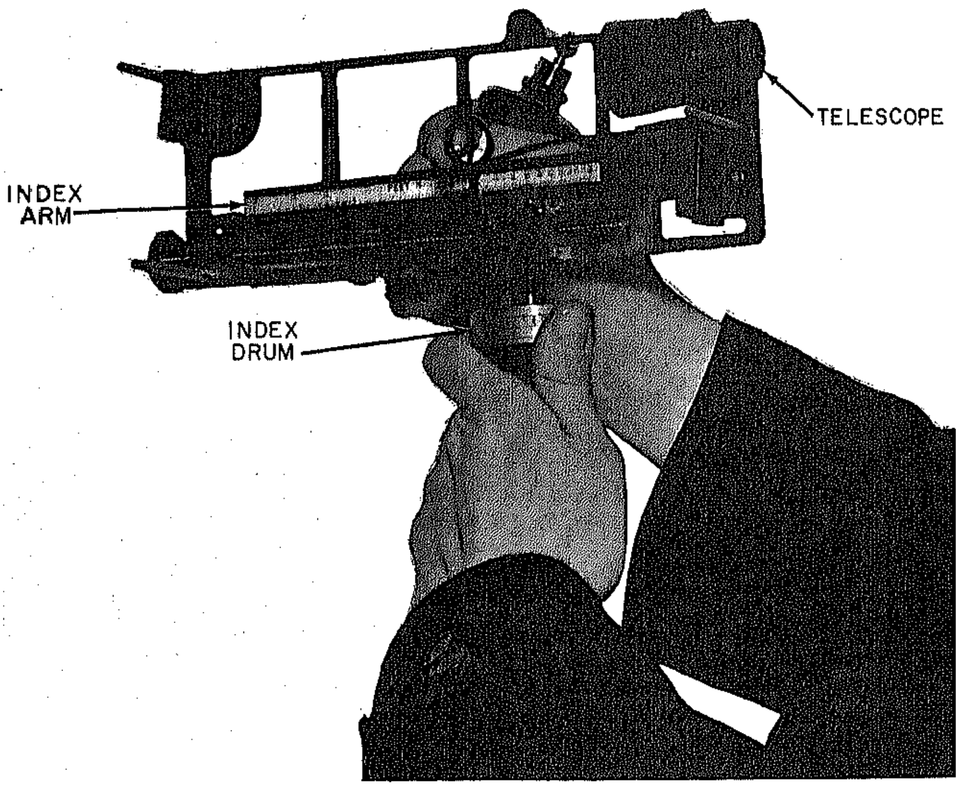


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Figure 9-7.—Fisk-type stadimeter.

when a ship's position is being determined by bearing and distance of a fixed object of known height.

In using a stadimeter, the height of the object whose distance is desired must be known, and that height must be between 50 and 200 feet. (Usually, when measuring distances to ships, the height used is from the boot topping to the top of the mast or highest radar.) Distances are measured with reasonable accuracy up to 2000 yards. Beyond that range, the accuracy of the stadimeter decreases progressively.

PILOTING RECORD

All bearings, ranges, and soundings used in piloting must be recorded in a bearing record log. To make this recording easier, the Navy publishes a Standard Bearing Book, OPNAV 3530/2 for use by all ships. (See figure 9-8 for a sample page from the Standard Bearing Book.) This record is maintained so that a ship's piloting track can be reconstructed if overlays are destroyed or charts are erased. The bearing record must be kept up to date and accurate and must contain all the information used to obtain each fix, including time, name of navigational aid on which bearing or range was taken, bearing or range, and depth of water.

FIXES

A fix is defined as the point of intersection of two or more simultaneously obtained lines of position. The symbol for a fix is a small circle around the point of intersection. For better identification, it is labeled with time expressed in

RECORD GYRO BEARINGS

PLACE: *SANTA CRUZ* GYRO ERROR: *1°E*

DATE TIME	EAST PT.	SKUNK PT.	GULF ISL. LT.	ANACAPA ISLAND LT.		DEPTH
21	APRIL	1976				
0800	220	272	112			60 FT.
0820			058-R2.5			65 FT.
	BROWN PT.					
0840	042	308	350			85 FT.
	SAN PEDRO RT. TANGENT	ANACAPA MOUNTAIN				
1100	344	018		038		170 FT.
1200	359		291	035		320 FT.
1205	SECURED	— [illegible] QM3 (SS)				

Figure 9-8.—Page from Standard Bearing Book. 69.141

four digits. Fixes may be obtained by means of the following combinations of lines of position.

1. A line of bearing and a distance arc.
2. Two or more lines of bearing.
3. Two or more distance arcs.
4. Two or more ranges.
5. A range and a line of bearing.
6. A range and a distance arc.

Examples of these combinations are shown in figure 9-9.

Because two circles may intersect at two points, two distance arcs used to obtain a fix are somewhat undesirable. In making a choice between two points of intersection, however, a navigator may consider an approximate bearing, a sounding, or the ship's DR position.

When a distance arc of one landmark is used with a bearing of a different landmark, the navigator may again be faced with the problem of choosing between two points of intersection.

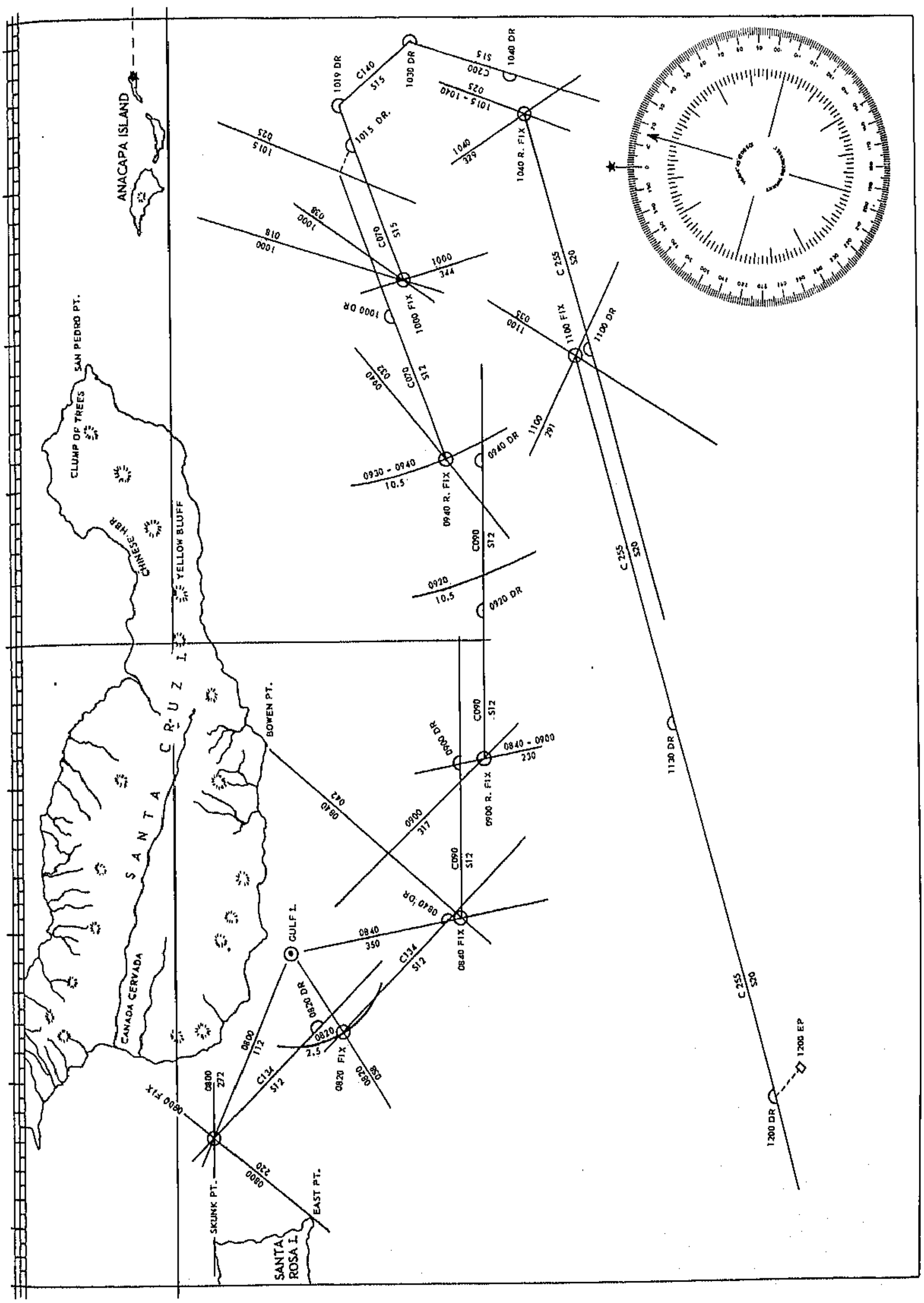

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Figure 9-9.—Piloting plot.

SYMBOL	DESCRIPTIVE LABEL	MEANING
	FIX	AN ACCURATE POSITION DETERMINED WITHOUT REFERENCE TO ANY PREVIOUS POSITION. ESTABLISHED BY ELECTRONIC, VISUAL, OR CELESTIAL OBSERVATIONS.
	DR	DEAD RECKON POSITION. ADVANCED FROM A PREVIOUS KNOWN POSITION OR FIX. COURSE AND SPEED ARE RECKONED WITHOUT ALLOWANCE FOR WIND OR CURRENT.
	EP	ESTIMATED POSITION. IS THE MOST PROBABLE POSITION OF A VESSEL, DETERMINED FROM DATA OF QUESTIONABLE ACCURACY, SUCH AS APPLYING ESTIMATED CURRENT AND WIND CORRECTIONS TO A DR POSITION.

69.149

Figure 9-10.—Navigation plotting symbols.

Navigation plotting symbols and their meanings are shown in figure 9-10. When these symbols are used, it is not necessary to label the position (except for time), since a glance tells what type of position is indicated. Any simple, clear, logical, system of labels is suitable.

SELECTING LANDMARKS

In selecting landmarks for use in obtaining lines of position (LOP), two considerations enter the problem; angle of intersection and number of objects.

Two lines of position crossing at nearly right angles will result in a fix with a small amount of error as compared to two lines of position separated by less than a 30° spread. If a small, unknown compass error exists in both examples, or if a slight error is made in reading the bearings, the resulting discrepancy will be less in a fix produced by widely separated lines of position than in a fix obtained from lines of position separated by only a few degrees.

If only two landmarks are used, an error in observation or identification may not be apparent. By obtaining three or more lines of position, each LOP acts as a check. If all LOPs cross in a pinpoint or form a small triangle, the fix may be considered reliable. Where three lines of position are used, a spread of 120° would result in optimum accuracy.

Sometimes a navigator has no choice in lan marks, their number, or their spread. Tl navigator then must use whatever referen marks are available, no matter how undesirabl In evaluating the ship's fix, the number of lan marks and their spread should receive consider tion. When three lines of position cross, formir a large triangle, it is difficult to determir whether the triangle is the result of a compa error or an erroneous LOP. The intersection c four lines of position usually indicates whic LOP is in error.

COMPASS ERROR IN PLOTTED FIX

When lines of position cross to form a smal triangle, the fix is considered to be the center o the triangle, at a point determined visually. I the size of the triangle appears significantl large, it is possible that the compass has a error, and the ship's actual location may be out side the triangle.

To eliminate the compass error from the fixes, assume an error; then, by successive trial and assumptions, determine the actual error. If the assumed error is labeled improperly (east or west), the triangle will plot larger. If the error proves to be labeled properly but the triangle still exists, although reduced in size, the navigator on the second trial should assume a larger error in the same direction.

HORIZONTAL SEXTANT ANGLES

In piloting, the most accurate fixes may be obtained by measuring the horizontal angles between three fixed objects whose exact locations are known.

By use of a sextant, horizontal angles are measured between the object in the middle and the one on either side.

A point to bear in mind is that this method should not be used when the three objects are on a circle whose arc passes through the observer. (See figure 9-11.) Such situations are known as "swingers" or "revolvers." To avoid swingers or revolvers, objects selected should lie in a

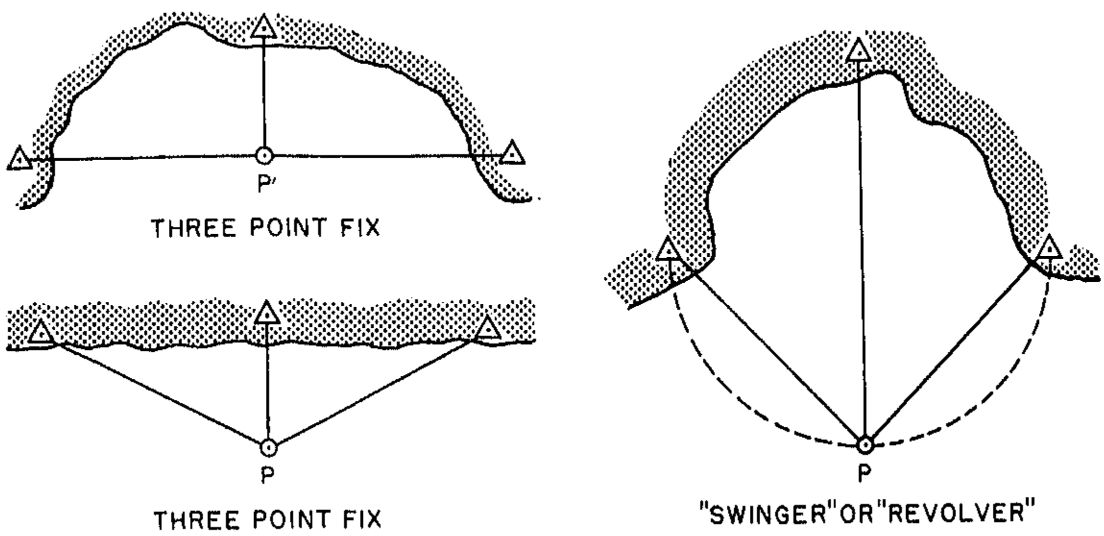

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Figure 9-11.—Horizontal sextant angles.

straight line. When this selection is impractical, the object in the middle should be nearer the observer than the other two, or the angle between the middle object and the two end ones should approach or exceed 180°.

Horizontal sextant angles should be taken as nearly simultaneously as possible, preferably by two people on a predetermined signal. The angles are then set on a three-arm protractor. The protractor arms are then aligned to the objects on the chart, and the observer's location is the focal point of the three arms.

The three-arm protractor is a device of metal or rigid plastic, and has one fixed and two movable arms. (See figure 9-12.) The fixed (center) arm is secured to (or is part of) a graduated circle. The other two arms, fitted with clamping devices, pivot around this circle. The left and right arms may be set to form any angle with the middle arm. All arms have a common vertex. To determine an observer's exact location, the three-arm protractor may be aligned to the beacons on the chart, as seen in the illustration.

RUNNING FIX

So far we have talked about methods for obtaining a definite fix by piloting. Whether obtained by bearing and distance of a single object or by cross bearings of two or more objects, the lines of position are located exactly. Their intersection, consequently, is the ship's location at the time the bearings were taken.

A running fix, on the other hand, is what you might call a dead-reckoning fix, because the location of one of the lines of position is determined by dead-reckoning calculation of the ship's direction and distance traveled during an interval. The most common example of a running fix is a situation where a line of position obtained at a certain time is advanced. Figure 9-13 shows how a line of position is advanced. At 1500 the ship took a bearing of 245° on light E. Since then it has run for 20 minutes at 12 knots on course 012°. Twenty minutes at 12 knots means that the ship has run 4 nautical miles. This distance is measured to scale along the course line in the direction traveled, and the new line of position is drawn at this point parallel to the old one. The new line of position is labeled "1500-1520" to show that it is a line of position advanced the amount of the run in that interval. At 1500 the ship was somewhere along the 1500 line of position. At 1520 it is somewhere near a point on the 1500-1520 line. The exact

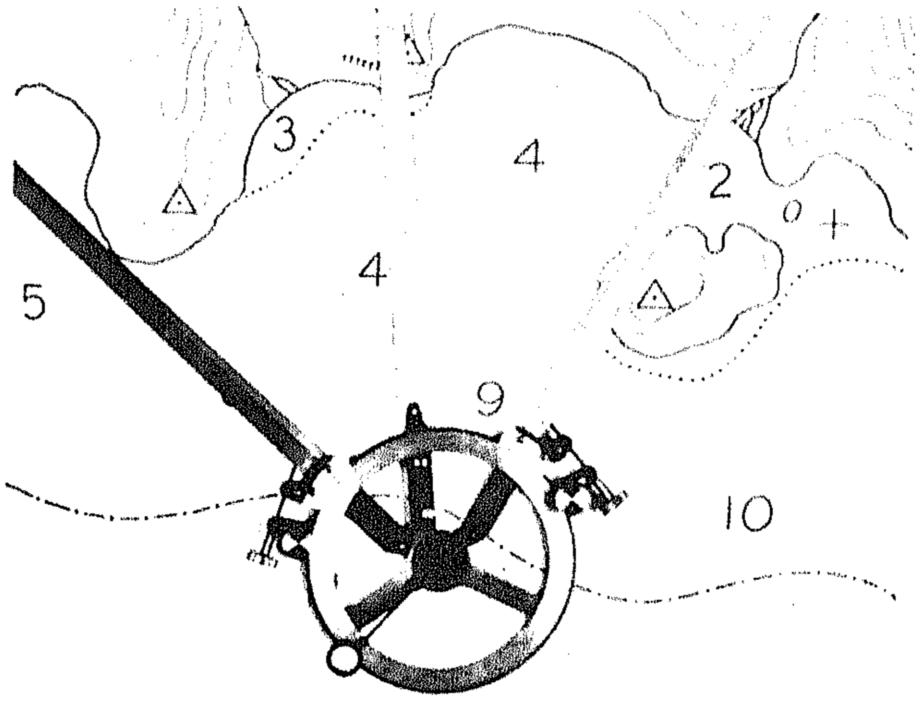

Figure 9-12.—Three-arm protractor.

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spot depends on how accurately the direction and distance traveled are represented by the measured distance along the course line.

In all applications of the two-bearing principle, the basic doctrine can be stated as follows: The distance a ship runs on the same course to double the angle of bearing of an object on its bow equals its distance away from the object at the time of the second bearing.

You do not really need to know why the basic doctrine is true, but a knowledge of trigonometry will give you the answer readily. The most common and convenient application of this principle is with bow and beam bearings. Figure 9-14 illustrates how it works. A ship starts to determine its run from the time the fixed object shown bears 315° relative, which is 45° on the ship's port bow. By the time the object is 270° relative (90° from the bow, or abeam), the ship has run 1.0 nautical mile. At the time of the second bearing, the object is also 1.0 nautical mile distant on the beam. The navigator now is able to locate a running fix by bearing and distance of a single object. It is called a running fix because the navigator must calculate by DR methods the direction and distance run between bearings.

RELATIVE MOTION

You have already learned that you must keep a ship in safe water and navigate it from one point to another by using all available means. Essentially, we have discussed only true (geographical) movement; that is, the motion of ship through the water and over the ground. The course and speed of a ship through the water represent its movement over the ground (disregarding the effect on the ship of such variables as the tide, current, and wind). However, even actual movement is relative because it is relative to the Earth's surface,

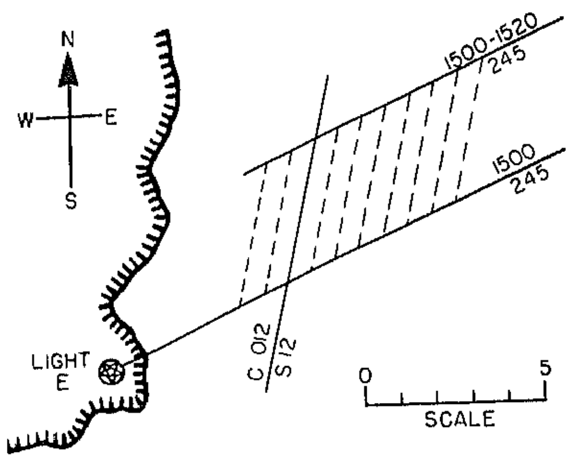

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Figure 9-13.—Advancing line of position.

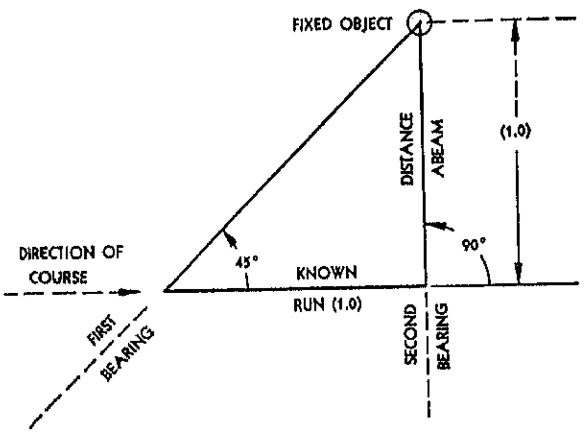

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Figure 9-14.—Bow and beam bearings.

which is a moving body. All motion is relative to some reference and it is very important when discussing motion to clearly define the reference point used.

Relative motion is defined as the apparent movement that takes place between two objects when one or both are moving independently.

For a practical application of relative motion at work, consider these three examples:

1. As you stroll along a sidewalk, an understanding of relative motion prevents you from colliding with other pedestrians.

2. When you are driving an automobile, a comprehension of relative motion prevents you from running into other cars.

3. As you play ball, this knowledge enables you to determine at which point to intercept the ball in order to catch it.

Let's consider a few examples of relative motion in everyday life. These examples are included to explain why relative motion is defined as apparent movement.

Driving along a street in a car, you notice a lamppost on the right-hand curb in the next block. As you approach that point, the lamppost changes bearing very slowly to the right. As you draw nearer, the motion to the right tends to increase until you are even with the lamppost, then the lamppost disappears behind your line of vision. The lamppost actually remained stationary; but, in relation to your movement, it appeared to have motion to the right. The foregoing is an example of relative movement with only one object moving.

Now, let us focus on two moving objects under circumstances similar to the preceding example. Assume you are driving down the same street in the same automobile but, instead of the lamppost on the curb, you see a person walking along the sidewalk in the same direction you are headed. As you drive along, the pedestrian changes bearing very slowly to the right. As you continue, this motion to the right increases until the person moves far enough to the right and behind your line of vision. The relative motion of the person walking was opposite to your direction of movement because of your greater speed, but the true direction of motion of the person walking was the same as yours.

The concept of relative movement is illustrated in figure 9-15 in which two ships leave the same anchorage, one sailing north and the other sailing east. If each ship makes 20 knots, each will travel 5 nautical miles in the first 15 minutes. At that time, the ships will be approximately 7 miles apart. The ship sailing east will now be southeast of the other ship. The movement that has taken place between them—leaving the same spot and being approximately 7 miles apart after 15 minutes—is different from the geographical movement of either ship. It is the result of both

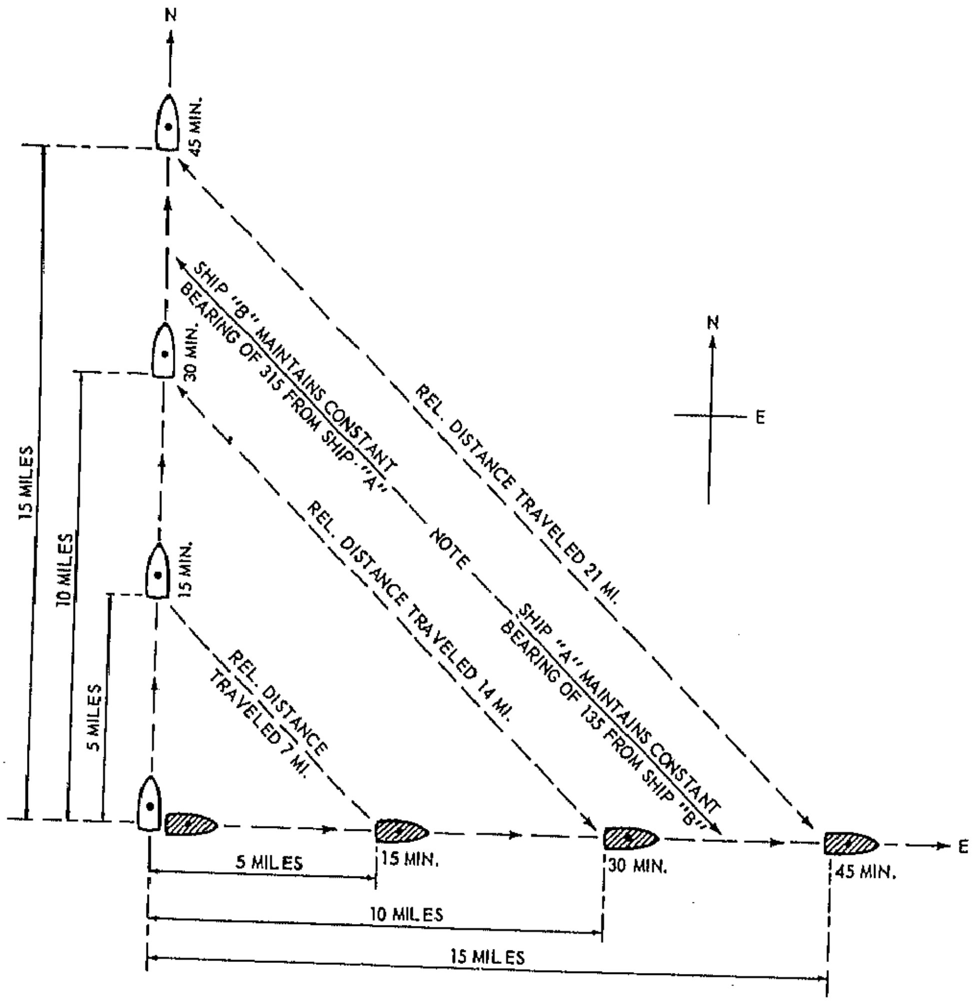

Figure 9-15.—Relative movement.

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of their geographical movements measured relative to the other.

If both ships follow their respective routes for another 15 minutes, each will have traveled 10 nautical miles from the starting point and they will be separated by approximately 14 miles. After 45 minutes, they will be separated by approximately 21 miles, although each will have sailed only 15 miles. Each ship, as far as the other is concerned, is moving about 7 miles farther every 15 minutes, but always on the same relative bearing. Thus, in addition to the motion of the individual ships—one to the north and the other to the east—there is also a motion existing between the two in a southeast-northwest direction. This motion is the relative movement between them.

RELATIVE PLOT

A relative plot is a drawing to scale showing the position of one moving object relative to other objects. Since we are interested in the movement of one ship relative to another, we can represent relative motion directly if we select one ship as the reference ship and plot the other ship's position by using bearing and distance

from the reference ship at set time intervals. These plots are termed "relative positions."

The fixed ship, termed "reference ship," is placed at the center of the diagram and is normally labeled "R." Because plotters are interested chiefly in the position of other ships with respect to own ship, it is usually preferable to designate own ship as reference ship. If in formation, however, and maneuvering with respect to the guide ship, the guide should be designated as reference ship. It follows that any ship except a reference ship is shown in a different position on the plot.

Figure 9-16 shows ship A proceeding on course 000° at a speed of 15 knots, while ship B is on course 026.5° at speed 22 knots. When ship A is at A1, ship B is at B1; when ship A is at A2, ship B is at B2, and so on. The full lines represent navigational plots of these two ships. Their bearing and distance at any time can be determined directly by measurement.

In figure 9-17, various positions shown in figure 9-16 are presented on a plan position indicator (PPI) scope for each ship. Note that they form a straight line. It can be seen that although ship B is actually on course 026.5°, its movement

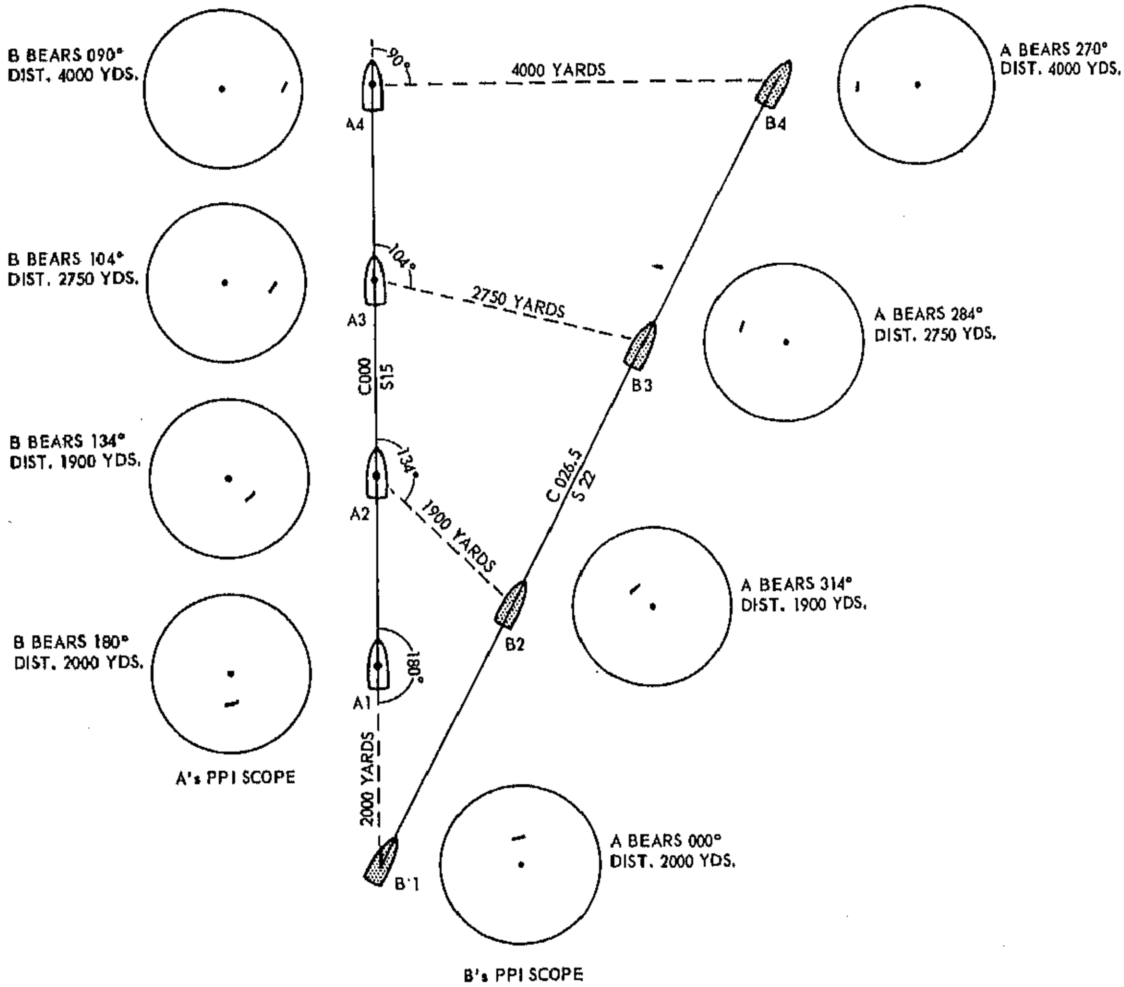

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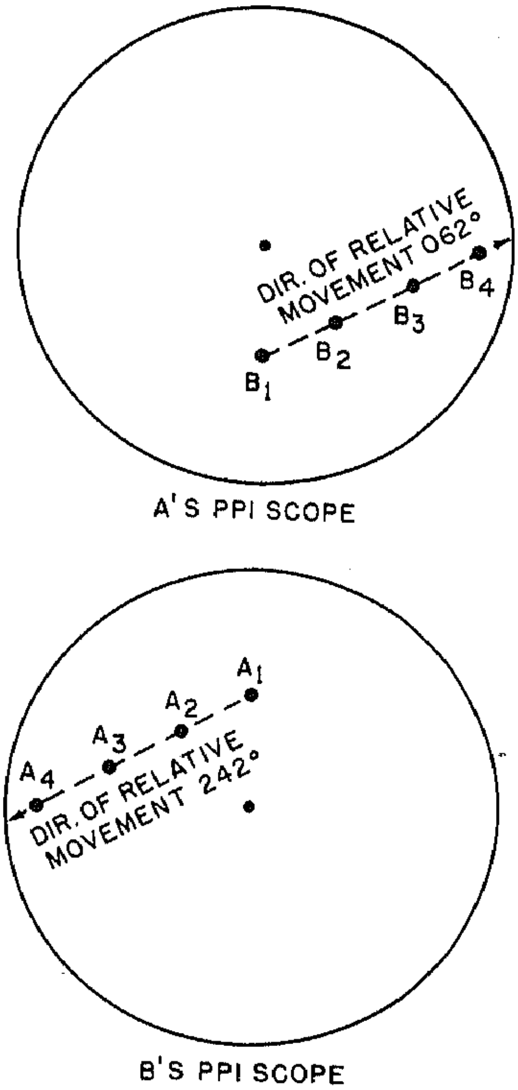
Figure 9-16.—Relative movement on a navigational plot.



58.92

Figure 9-17.—Relative movement on a radar PPI scope.

relative to ship A is in the direction 062°. Similarly, the direction of relative movement of ship A with respect to ship B is the reciprocal of this direction, or 242°, although ship A is actually on course 000°.

The PPI scope permits visualization of relative movements, inasmuch as all positions of the target ship on the scope are relative to own ship. Hence, motion observed on the PPI scope is relative movement. True motion is seen on a PPI scope only when own ship is stationary.

MANEUVERING BOARD

The maneuvering board (MB), figure 9-18, has been designed specifically for solving problems involving relative movement between ships underway. The maneuvering board is a drawing to scale showing the position of one moving object relative to other moving objects. The center of the maneuvering board is the reference ship from which the positions of other ships are plotted. It is labeled with the capital letter R.

Maneuvering boards are printed with radial straight lines (to aid in plotting bearings and courses) and concentric circles (to aid in plotting distance and speeds).

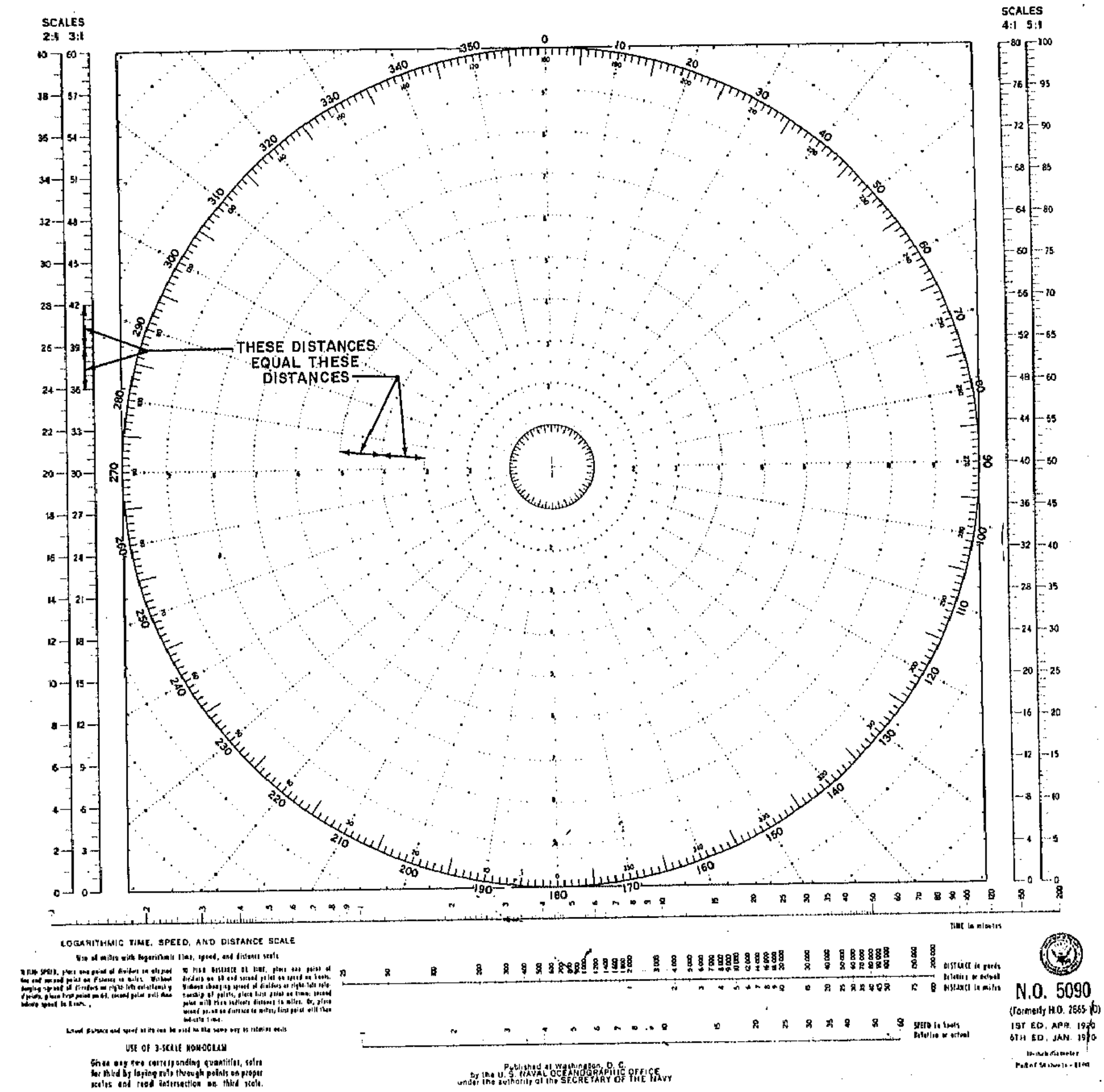
The maneuvering board has two sets of bearings printed along its outer circle. The outer numbers represent true bearings, and the inner set of numbers is printed as an aid in finding reciprocal bearings quickly. Notice in figure 9-18 that there are 10 circles. These circles represent units of distance and may be used to form a scale.

Ratio scales are provided on the left and right sides of the maneuvering board (figure 9-18) for convenience in adopting a suitable reduction for quantities pertaining to the problem at hand.

Numerical spacing on each scale is proportionate to that of the circle in the plotting area. When selecting one of these scales, the distance of each circle must be amplified accordingly. For example, when using a 1:1 scale (circle spacing in plotting area) with each circle representing 1,000 yards, the 5 circle represents 5,000 yards. If the 2:1 scale is used, the 5 circle would represent 10,000 yards (5,000 × 2).

Ordinarily, the distance between circles on the maneuvering board represents from 1,000 to 5,000 yards in the relative plot, and from 1 to 5 knots in the vector diagram (discussed later). Any scale may be selected if it is adequate and convenient to include all required ranges and speeds within the 10 concentric circles on the board.

Deciding the correct range scale to use is comparatively easy. There are five different scales, so the maximum range for these scales



36.65(58)B

Figure 9-18.—Maneuvering board.

would be 10 (units of distance for the 1:1); 20 (units of distance for the 2:1), and so on. Thus, if range to a contact is 14,000 yards, the 2:1 scale can be used because this range falls between 10,000 and 20,000 yards. The accompanying table is designed to assist in selecting range scale. If range is—

From	To	Use Scale
0 yard	10,000 yards	1:1
10,000 yards	20,000 yards	2:1
20,000 yards	30,000 yards	3:1
30,000 yards	40,000 yards	4:1
40,000 yards	50,000 yards	5:1

PLOTTING OWN SHIP IN CENTER OF MANEUVERING BOARD (MB)

With present-day accurate PPI repeaters and precise radars, a direct system of correlation between the picture on the radar repeater and the relative plot on the MB is easily accomplished by always placing own ship in the center of the maneuvering board. Since own ship is always the center of the radarscope on a PPI, the PPI can be used as a maneuvering board, and rapid and fairly accurate maneuvering solutions can be worked directly on the face of the PPI. When precise solutions are desired, the maneuvering board must be used.

Several advantages result from placing own ship in the center of the MB. The most important benefits are that (1) the entire plot on the maneuvering board can be seen without conversion on the PPI and (2) range and bearing of contacts can be plotted directly. Another advantage is that the relative picture drawn on the MB can be seen developing on the PPI, so that any error in plotting becomes immediately apparent, as stated earlier in this chapter.

Positions of contacts in a relative plot on a maneuvering board are designated by the capital letter M (for maneuvering ship) accompanied usually by a time. Relative plots are determined by the bearing in degrees, usually true, and measured in yards from own ship or from the center of the maneuvering board (R).

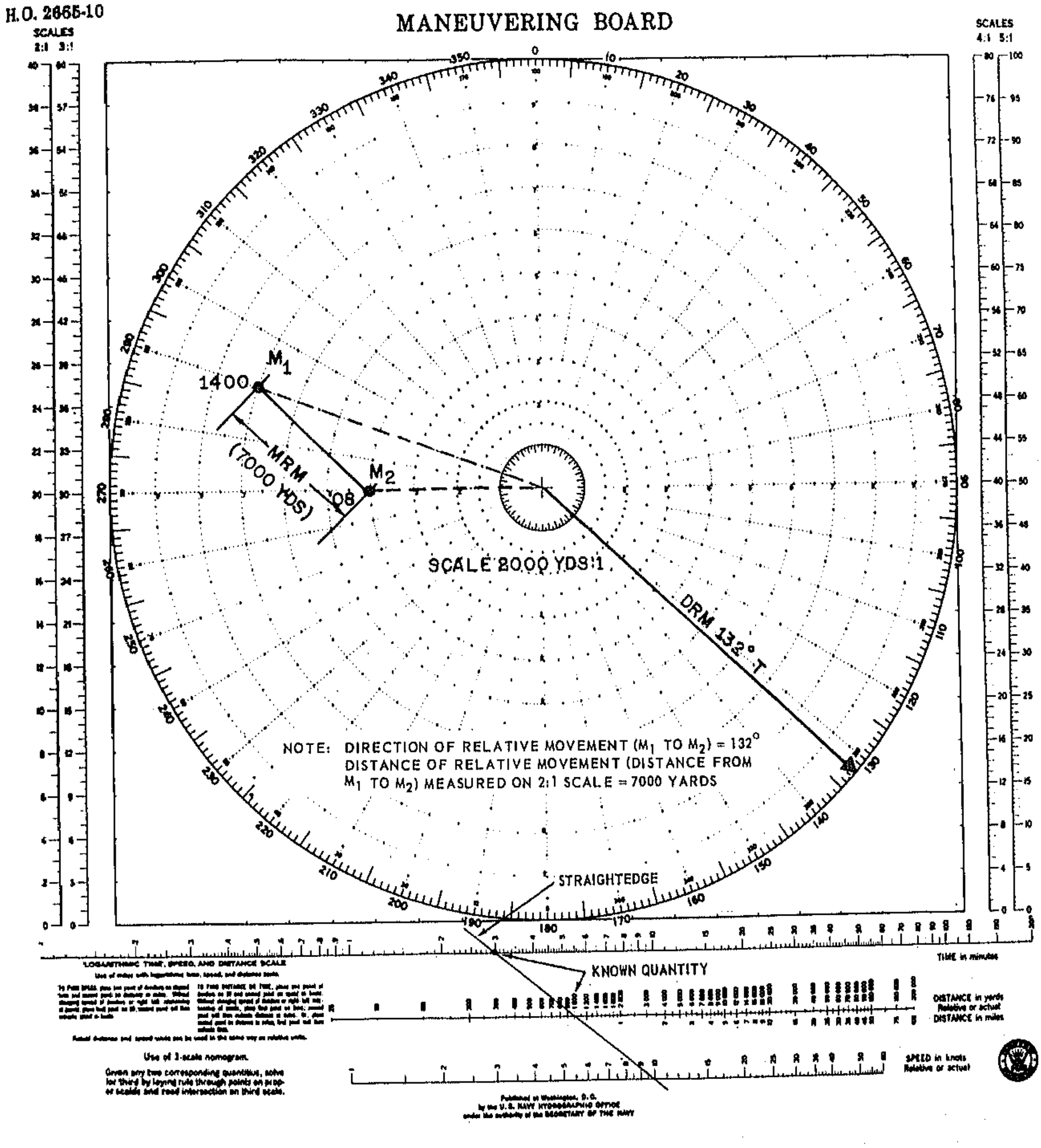
The first range and bearing of the maneuvering ship is plotted and is labeled "M_1"; the next position (range and bearing) is plotted and labeled "M_2." If more than two positions of the maneuvering ship are plotted, they are labeled "M_3", "M_4", "M_5", etc. Relative to the reference ship (R), the plots from M_1 to M_2, etc., show the relative movement of the maneuvering ship.

The direction of the line joining the plots from M_1 to M_2, etc., represents the direction in which the maneuvering ship (target) is moving with respect to the reference ship (R). This direction is called the direction of relative movement (DRM) and is expressed as a true bearing. (See figure 9-19.) Remember, this is not a true movement; it is the relative movement, which is the result of the reference ship's course and speed and the maneuvering ship's course and speed, which makes the maneuvering ship travel down the DRM line.

The distance between the position M_1 and M_2, measured to the same scale used to plot M_1 and M_2, is the distance the maneuvering ship (M) traveled with respect to the reference ship (R). This is called relative distance and is labeled "MRM" (measurement of relative movement). (See figure 9-19.) Again, remember, this is not a true distance; it is the relative distance.

Relative distance then is the measurement of the distance, to scale, between M_1 and M_2, etc. It is important to remember that you must use the same scale used to plot M_1, M_2, etc., for this measurement. Once this measurement is made and its value determined (in miles or yards), we then introduce the element of time between plots M_1 and M_2, etc., and determine the speed of relative movement (SRM). Speed of relative movement is the speed at which the contact is moving relative to the reference ship. The SRM is determined by using the MRM for the period of time elapsed between the plots (M_1 and M_2, etc.). To solve for SRM, the nomogram at the bottom of the maneuvering board affords a ready means of interconverting time, speed, and distance, and solving graphically for any one of these quantities when the other two are known.

Figure 9-19 illustrates time-speed-distance scales. The top line is the time line or logarithmic scale in minutes; the middle one is the distance



36.65(69E)A

Figure 9-19.—Direction and distance of relative movement.

scale. Numbers on top of the distance scale give distance in yards; those below, distance in miles. The bottom line is the speed scale in knots.

The words "relative" or "actual," used with speed and distance scales, are included only to inform the plotter that both relative and actual problems may be solved. When relative distance is used, the corresponding speed must be relative.

Time-speed-distance scales are based on the formula: Distance = speed × time. These scales are so arranged that, by marking off any two known values in this formula and laying a straightedge through the points so marked, the correct value of the third quantity is the point of intersection on the third scale. It was observed (in figure 9-19) that the contact traveled 7000 yards in 8 minutes. What is the contact's SRM? On the time scale locate 8 minutes, and on the distance scale locate 7000 yards. Draw a straight line through these two points and extend it across the speed scale. The line will cross the speed scale at 26.5 knots; this is the SRM.

3-MINUTE RULE

Another shortcut in determining speed or distance traveled is the method known as the 3-minute rule. It is a simple method of solving for relative speed, without having to use the logarithmic scales. The rule is based on the number of yards the contact travels in 3 minutes. An explanation of the 3-minute rule follows.

1. One knot equals 1 nautical mile per hour.

2. One knot equals approximately 2000 yards per 60 minutes.

3. If 1 knot equals 2000 yards per 60 minutes, then by reducing the distance traveled in 3 minutes, a ship covers a distance of 100 yards.

$$\frac{3}{60} = \frac{1}{20} \times 2000 = 100 \text{ yards}$$

4. Therefore, for every 3 minutes of travel, each knot of speed represents a distance of 100 yards. Thus, if a ship travels 1200 yards in 3 minutes, its speed is 12 knots. (Point off or drop the two places from the right side of the number being divided.)

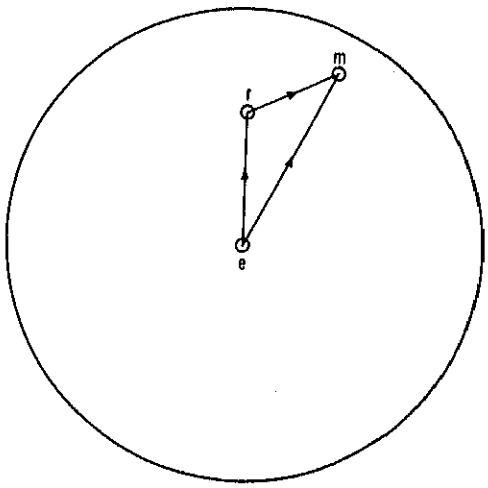
To summarize the 3-minute rule: The number of hundreds of yards traveled by a ship in 3 minutes is the speed of the ship in knots.

VECTOR DIAGRAM

Thus far we have concerned ourselves with only the relative plot; i.e., DRM, SRM, and MRM. We have not mentioned the true course and speed of the contacts involved, which at the beginning of this discussion we found were a direct cause of the effect known as relative motion. To determine the true course and speed of a contact, we must develop a vector diagram.

A vector is a straight line representing direction of movement and speed of movement. Direction (course) is indicated by drawing the line from the center of the maneuvering board toward the direction indicated on the outer bearing circle. (See figure 9-20.) Speed is indicated by the length of the vector drawn to scale.

The small letter _e_ is always at the center of the maneuvering board, small letter _r_ is used at the arrowhead of the speed vector for own ship, and small letter _m_ is used at the arrowhead of the speed vector of the other ship.



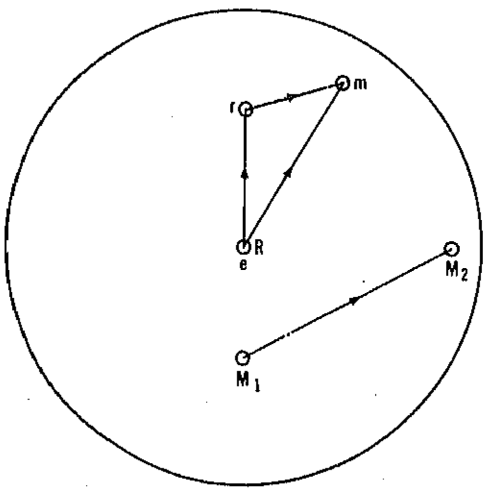
36.65(58)A

Figure 9-20.—Vector diagram.

A vector diagram, frequently referred to as a speed triangle, is illustrated in figure 9-20. This diagram is made up of six factors:

1. Course of reference ship direction from *e* to *r*: $e \rightarrow r$
2. Speed of reference ship distance from *e* to *r*: $e \rightarrow r$
3. Direction of relative movement (DRM) of maneuvering ship with respect to reference ship distance from *r* to *m*: $r \rightarrow m$
4. Speed of relative movement (SRM) of maneuvering ship with respect to reference ship distance from *r* to *m*: $r \rightarrow m$
5. Course of maneuvering ship direction from *e* to *m*: $e \rightarrow m$
6. Speed of maneuvering ship distance from *e* to *m*: $e \rightarrow m$

With *e* always at the center, maneuvering ship's course and speed and own course and speed have the same point of origin at the center. The line drawn from the head of own speed vector *r* to the head of the maneuvering ship's speed vector *m* is always the direction of relative movement. The direction of relative movement will always go from *r* to *m* (see figure 9-21) and the arrowhead is always placed at *m*. The speed scale used in the vector diagram must be common to all vectors.



36.65(58)A

Figure 9-21.—Complete relative movement plot.

As can be seen, each line (or vector) represents both direction (course) and speed. The diagram must be labeled properly for correct interpretation.

MANEUVERING BOARD TECHNIQUE

Basically, the solution of all maneuvering board problems is the same. The relative plots must be connected, giving the M_1-M_2-M_x line, which is the DRM. Then the vector diagram must be completed. Once it is completed, the problem must be solved and the desired course, speed, etc., can be picked from the vector diagram. Four of the six values of a vector diagram (and time involved) must be known before any solution can be obtained.

In addition to basic problems that follow, plotters should know how to set up a maneuvering board to indicate a tactical organization and disposition of own force. This information can be obtained from ATP 1, volume 1.

Dutton's Navigation and Piloting and the Maneuvering Board Manual (Pub No. 217) serve as excellent references for information not covered in this chapter on uses of the maneuvering board.

MANEUVERING BOARD HINTS

The following guidelines are offered in working maneuvering board problems.

1. Read the problem carefully and understand it before proceeding with the solution. Check all numbers.
2. Determine the largest scale possible, both for speed and distance, and keep the same scale throughout the problem. Different scales may be used, however, for relative plot and vector diagram.
3. Avoid using reciprocals. This is particularly true when determining DRM if your ship is maneuvering on another ship.
4. Measure carefully. It is easy to pick off the wrong circle or make an error of 10° in a direction. Read the plotted answers accurately.
5. Plot only true bearings. Convert relative to true before plotting.

6. Label all points and put arrowheads on all lines.

7. Remember that relative speed is from $\underline{r}$ to $\underline{m}$, relative movement from M_1 to M_2.

8. Actual speed vectors always originate at the center of the board.

9. In actual problems, at least three plots are needed on a contact for accurate solutions.

10. Work a problem one step at a time.

11. Be methodical, be careful, and practice diligently.

CLOSEST POINT OF APPROACH

The closest point of approach (CPA) of a contact to the reference ship is the shortest distance between the extended relative movement line and the center of the maneuvering board and must be a line perpendicular to the relative movement line. The direction of this line from the center of the maneuvering board to the outer bearing circle is the true bearing of CPA.

Suppose that at 0530 CIC reports a contact bearing 236° at 18,000 yards. Ten minutes later the contact bears 229° at 14,000 yards. The plotter will want to figure the following data:

1. Direction of relative movement (DRM) of contact with respect to own ship.

2. True bearing of contact when it reaches minimum range.

3. Minimum range to contact (range to CPA).

4. Relative bearing of contact when it reaches CPA.

5. Speed of relative movement (SRM) of contact.

6. Time at which contact will reach CPA.

Plot the M_1 and M_2 positions of the contact. (See figure 9-22.) Mark on the bearing circle the first bearing (236°) and lay parallel rulers on that mark and the center of the board. For the range, select the largest scale practicable. Because of the range (18,000 yards), a 2:1 scale seems most logical. Place a dot where the bearing line crosses the 9 ring. This dot is the M_1 position. Plot the M_2 position in the same manner. Draw a line between the M_1 and M_2 positions, and extend the line past the center of the board as shown. To find direction of relative movement (DRM), lay parallel rulers along the relative movement line (M_1 to M_2), walk them to the center of the board, and draw a short line through the bearing circle. The DRM (or relative course) is 080°.

Two methods may be used to find the bearing of CPA. The first method is to add 90° to or subtract 90° from DRM. The plotter should be able to tell by inspection whether to add or subtract. In this example, the plotter must add. Hence, at CPA, contact will bear 170° (080° + 90° = 170°).

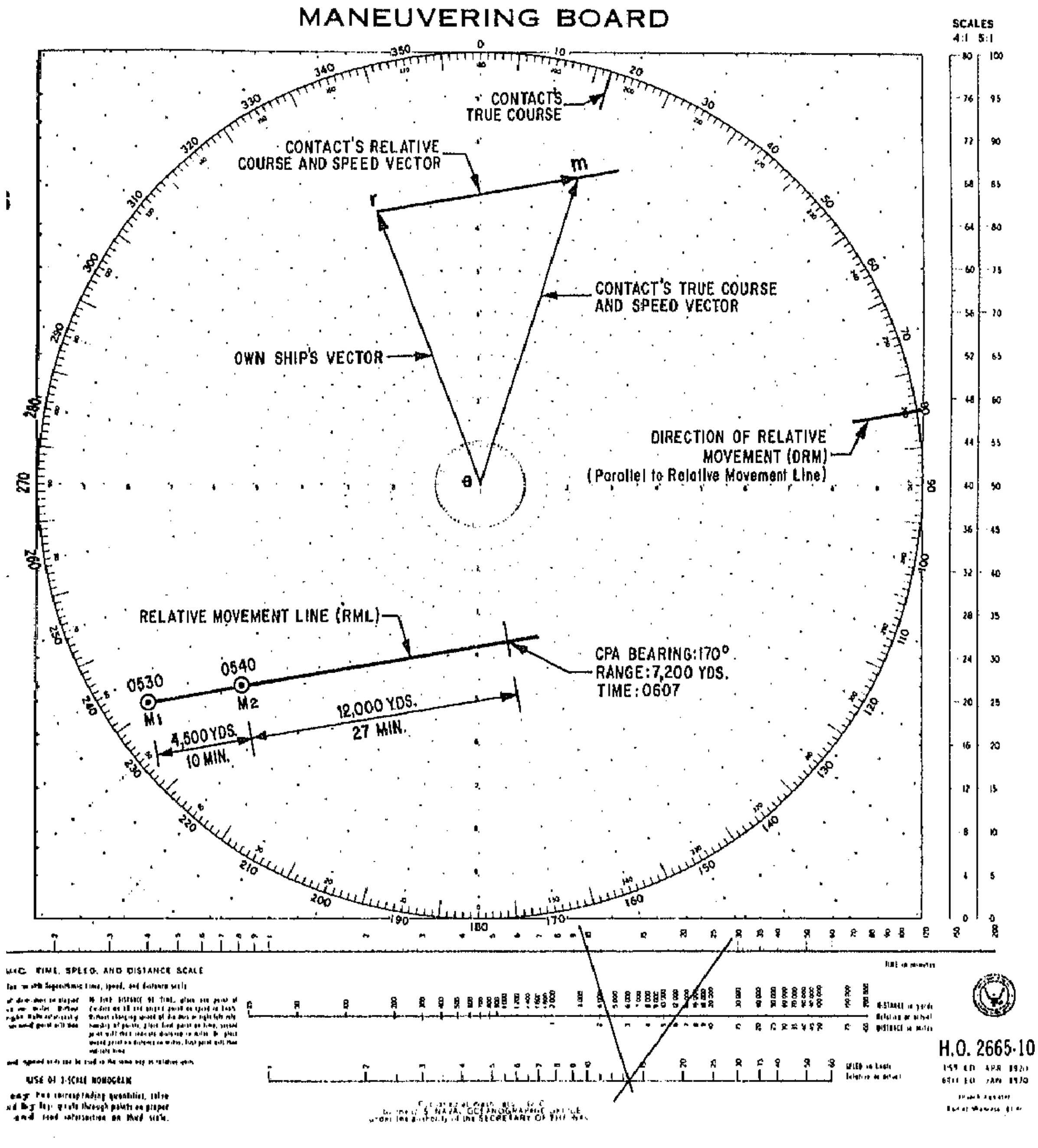
A second way to find the bearing of contact at CPA is to use a right-angle triangle. Lay one side of the right angle along the relative movement line (RML). Move the triangle along the RML until the vertical side passes through the center of the board. Draw a line across the relative movement line. Lay the parallel rulers along this line and the center of the board. Read the bearing on the bearing circle.

To find the range of CPA, use dividers to measure the distance on the proper ratio scale at the side of the board. In our example, the range is 7200 yards.

At times it helps to know what the relative bearing of CPA will be. To find relative bearing, subtract own ship's heading from the true bearing. Suppose that own ship's course is 340°. Obviously, one cannot subtract 340 from 170, but if 360° is added to the true bearing, the subtraction can be accomplished with no trouble. Thus, 170° + 360° = 530°; and 530° − 340° = 190° = relative bearing of CPA.

We now know four of the CPA items, but we still must know speed of relative movement (SRM) and time of CPA. To find SRM, measure the distance between M_1 and M_2 on the proper scale. This measurement is the distance traveled in 10 minutes. Mark those quantities on the nomogram at the bottom of the maneuvering board and find speed (explained earlier). Relative speed is 13.5 knots.

To find time of CPA, measure the distance from M_2 to CPA. With this quantity and relative speed, again go to the nomogram. Required information is the time required for the contact to



36.65(69E)B

Figure 9-22.—Solving for CPA course and speed.

get to CPA. Add this time (27 minutes) to the time at which the contact was at M_2. Time of CPA is 0607.

COURSE AND SPEED PROBLEM

To illustrate the procedures used to obtain the course and speed of a contact, use the situation in the previous problem. Much of the information obtained in the CPA problem is also used to figure the contact's course and speed. For example, DRM and SRM determine the direction and length of the vector _rm_ in the vector diagram.

In the previous problem, own ship's course and speed are 340°T and 20 knots. (See figure 9-22.) This vector is laid out from the center along the 340° radial line to circle 6.7 (3:1 distance scale), and labeled "_er_." Since it originates in the center of the maneuvering board, it is a true vector.

As previously discussed, DRM and the vector _rm_ are always parallel, and the direction M_1 to M_2 is always the same direction _r_ to _m_. Thus, if the DRM is paralleled up to the end of the _er_ vector, the origin and direction of the _rm_ vector are established. This is the relative course of the contact.

The relative speed (SRM) was determined to be 13.5 knots. That is the length of the vector _rm_. Using dividers, 13.5 knots is measured on the 3:1 scale and laid off from the _er_ vector along the relative course line. Now the direction and length of the vector _rm_ have been determined. Thus, the vector _rm_ indicates the relative course and relative speed of the contact.

To determine the true course and speed of the contact, simply complete the vector diagram by drawing a line from the center of the maneuvering board to the end of the _rm_ vector. This line is the _em_ vector; its direction indicates the target's true course, and its length indicates the target's true speed. In this example the contact is on course 017°, speed 22 knots.

NEW CPA

The CPA problem just solved shows there is nothing to worry about from the other ship as long as both ships continue on their present courses and speeds, but what happens if one ship changes course or speed?

Naturally, if the contact makes a change, the plotter must work out an entirely new problem.

If own ship is going to change course and/or speed, however, it makes sense to determine a new CPA before the change. This procedure may prevent putting own ship into possible danger. A new CPA can be found by using a vector diagram to solve for a new relative movement and relating the new _rm_ to the old problem.

Suppose that own ship is a DD, scheduled to rendezvous with a CV, and that the night order book contains an order to change course to 270° and speed to 10 knots at 0600.

In actual practice this problem would be worked out on the same board as the one in figure 9-22; but, to avoid confusion, a new board is used in our example. (See figure 9-23.) Needed information: Plot the old relative movement line and contact's true course and speed vector _em_ on figure 9-23.

First, determine contact's 0600 position on the relative movement line. (Remember that relative movement was computed on the 2:1 scale.) Contact was at M_2 at 0540. Therefore, go to the nomogram with relative speed (13.5 knots) and time (20 minutes). Mark this distance (9000 yards) from M_2 and label the position 0600.

Draw in the new own ship's vector 270° at 10 knots. (This vector was on the 3:1 scale.) Label own ship's vector _er_. Complete the triangle for the new relative movement _rm_. Walk the rulers to the center of the circle and draw a line across the bearing circle to find the new DRM, 038°. Walk the rulers down to the 0600 position and draw a line past the center of the circle in the new direction of relative movement. The new DRM plus 90° equals true bearing of the new CPA, 128°.

Measure the distance between the 0600 position and the new CPA. From the nomogram, find the time required to traverse that distance (08 minutes). New time of CPA is 0608, at distance 3200 yards.

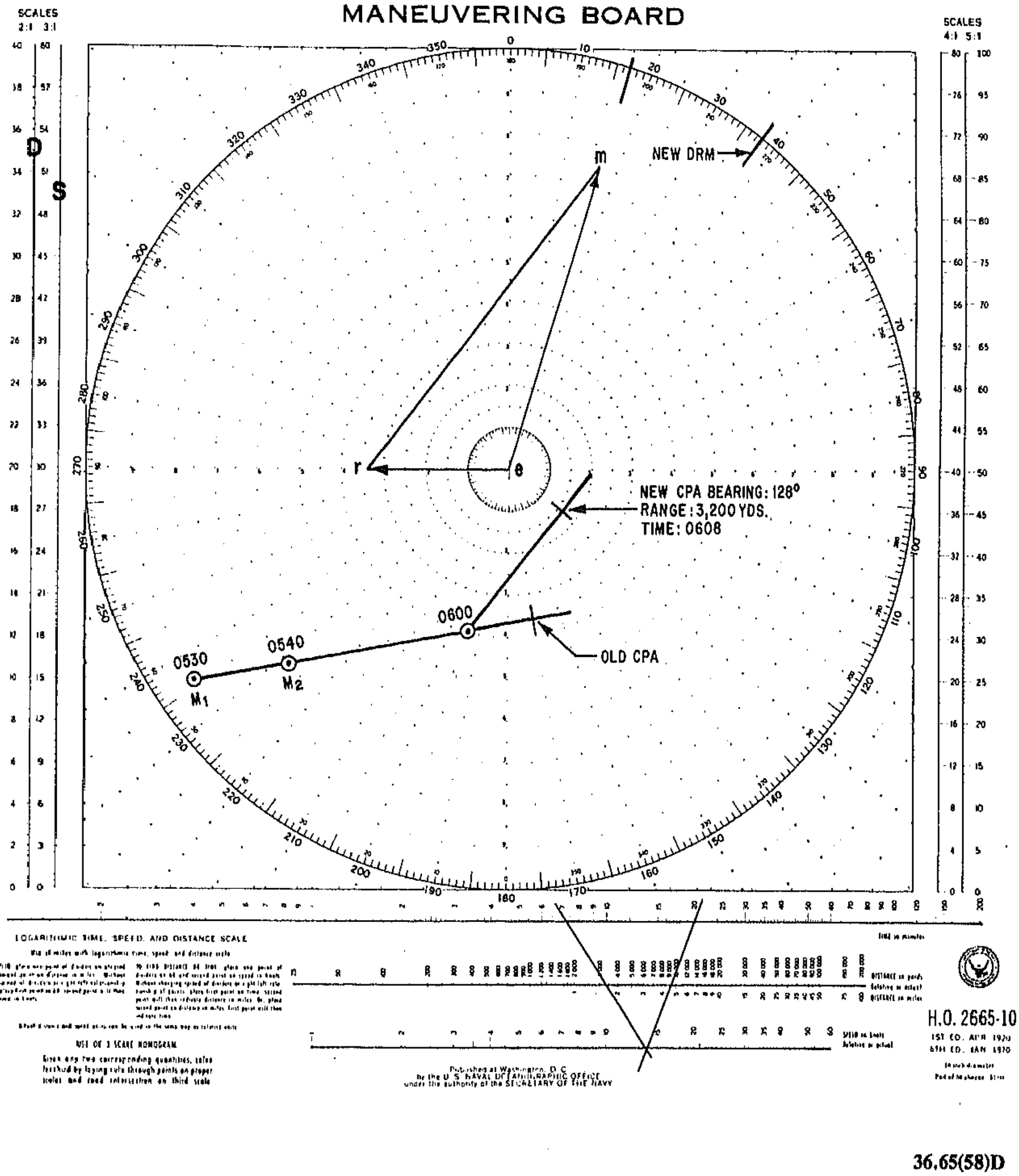


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Figure 9-23.—Solving for a new CPA.

CHAPTER 10

AMPHIBIOUS DUTIES

The Boatswain's Mate plays many important roles in an amphibious operation. As a First Class or Chief Boatswain's Mate, many of your duties will be aboard ship. There are, however, other duties to which you may be assigned, such as to a naval beach group or beachmaster unit, or as officer in charge of a landing craft, utility (LCU). In this chapter we will discuss some of these duties.

PONTOON ASSEMBLIES

One of the missions of the naval beach group is to provide pontoon causeways for an amphibious operation. *Boatswain's Mate 3 & 2*, NAVEDTRA 10121-G, provided you with some uses of pontoon assemblies. In this manual we will identify pontoons and associated equipment and discuss methods of causeway assembly, loading, and launching, along with LST-causeway marriages.

PONTOONS

Some of the most versatile equipment used in amphibious operations are pontoons. These are watertight steel boxes of high buoyancy made up of steel plates welded over an internal framework of structural steel beams. The top plates are called deck plates and the bottom ones bilge plates.

The Navy presently uses the P-series pontoons and equipment. The P-series comprises four individual units (shown in figure 10-1), and makes use of the T7A (figure 10-2) curved bilge pontoon of an older system.

Assembly

Units are laid end-to-end to form strings, and strings (usually three) are secured side-by-side to form causeway sections, lighterage and transfer barges, warping tugs, and platforms for floating cranes and other craft useful in amphibious operations.

These assemblies are designated by numbers such as 3 x 7 or 3 x 15. The numbers mean that the assembly is made up of 3 strings of 7 units or 3 strings of 15 units. Strings are assembled on launching ways laid out either parallel or perpendicular to the water.

Launching Ways

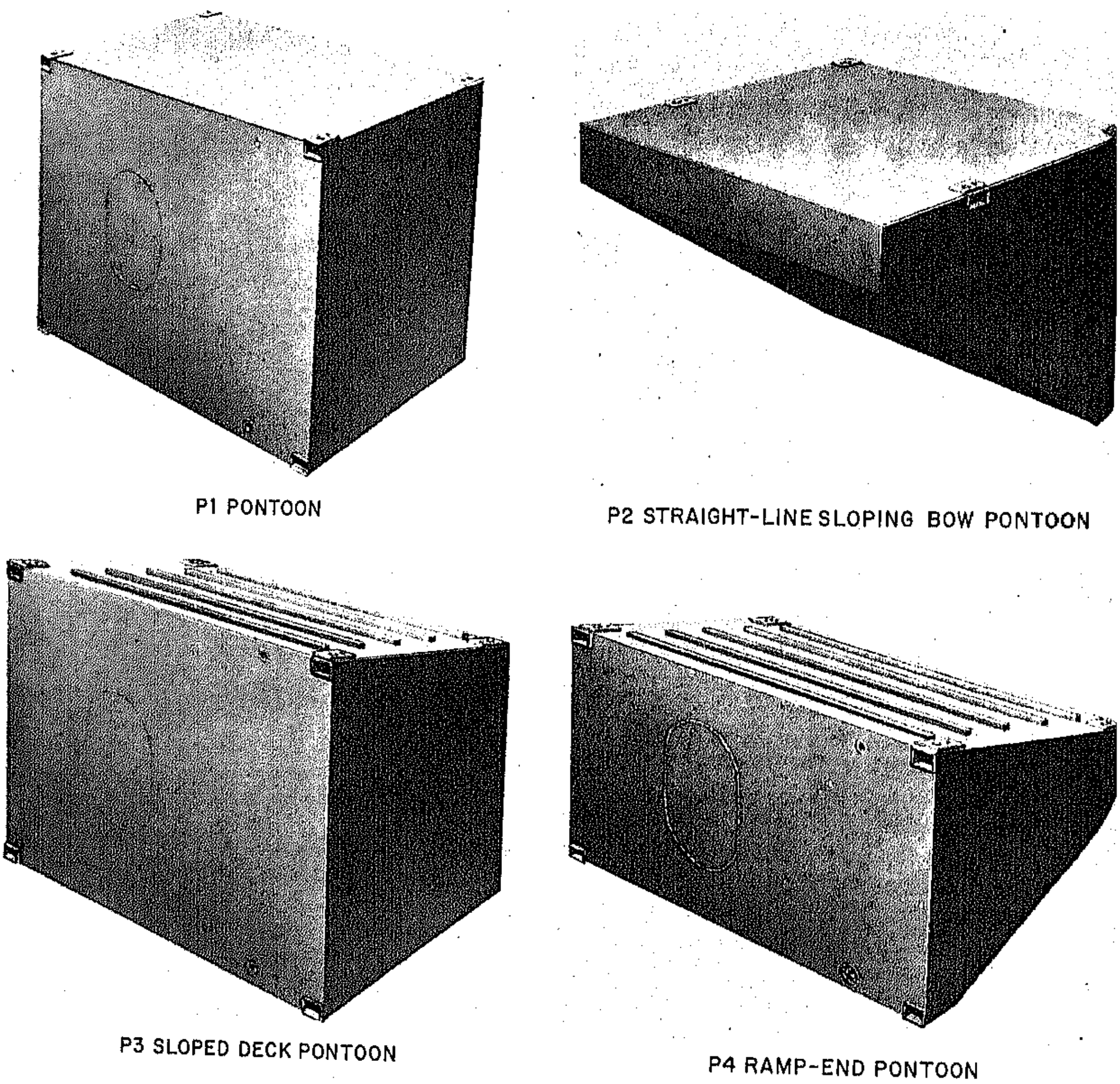
Before starting to assemble a string, it is necessary to decide which launching method is to be used, the side or the end.

In the side method (figure 10-3), the string is assembled along the edge of a pier or wharf and tipped over into the water. This method works well but requires considerable water frontage.

Another method is to assemble the string on launching rollers (figure 10-4) on an inclined way for end launching (figure 10-5).

If one or more cranes are available, strings may be constructed on a level way and hooked out by the crane(s).

A simple method of assembly, suitable for structures up to three strings wide, is to construct the strings parallel to the shoreline on rails perpendicular to the water. The pontoons are assembled on their sides so that one string can be added on top of the first string and a third on top of the other two. In this way, a complete structure may be assembled on land. When assembled, the structure is slid to within 6 inches of the ends of



29.180(58C)

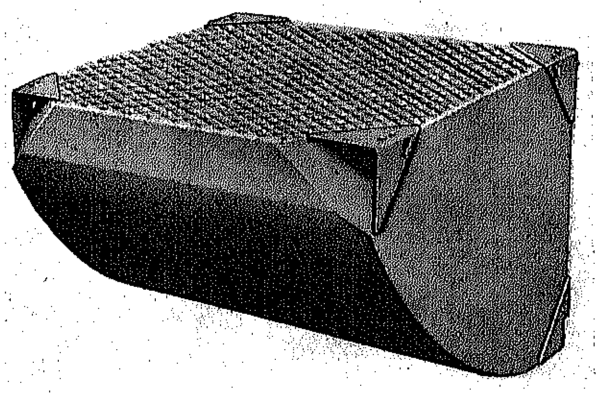
Figure 10-1.—P-series pontoons.

the rails, then tilted into the water. When cranes of sufficient capacity are available, the structure may be hooked into the water.

Assembling a String

Units of a string are bound together by four structural steel assembly angles that come in suitable lengths for assembling certain numbers of pontoons. To make up other lengths, assembly angles are butted and welded together. A special jig has been devised to hold the angles for welding and the angles are tapered at the ends so that the weld bead will not rise above the surface of the angle.

Angles are bolted to the units with A6 assembly bolts and FN1 flanged nuts as shown



29.180.2
Figure 10-2.—T7Acurved bilge pontoon.

in figure 10-6. The flange of the nut is large enough to prevent the nut from turning in the nut receptacle when the bolt is tightened. The shape of the nut allows it to clear the welds in the receptacle and seat properly when the nut is tight. To

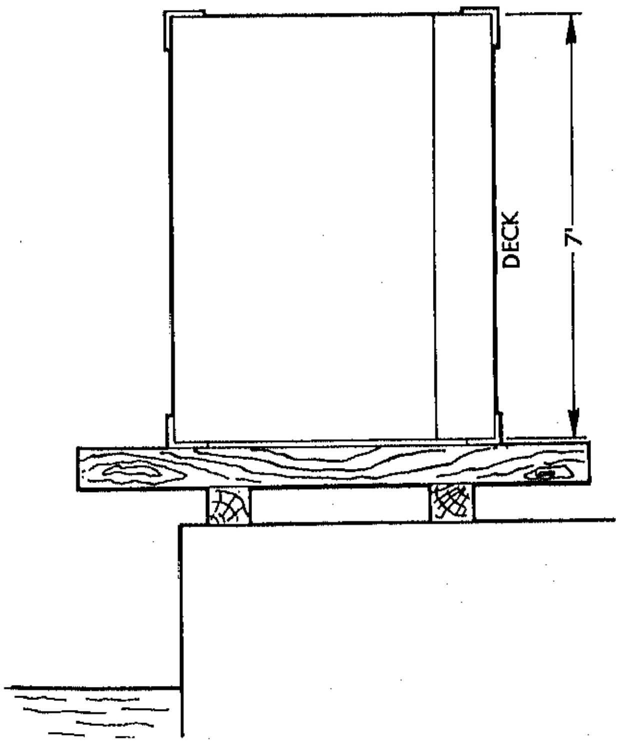


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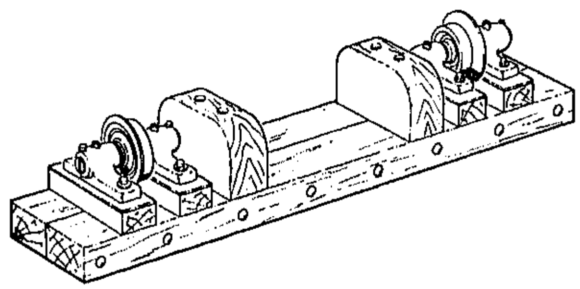
Figure 10-3.—Side launching.



58.180
Figure 10-4.—Launching roller.

keep bolts from working out, keeper plates (figure 10-7) are placed over the bolt heads and tack-welded to the assembly angles. Keeper plates are mandatory on the bottom of the pontoon structures to reduce maintenance problems.

The first step in assembling a string is to lay one deck and one bilge assembly angle on the launching ways. If launching rollers are used, the rollers correctly space the angles. Otherwise, the angles are placed approximately 5 feet and 2 inches apart. Bolt holes must be directly opposite each other. When properly placed, the angles must be anchored to keep them from moving.

Starting at the center, the units are placed on and loosely bolted to the angles. Notice in figure 10-6 the plates welded inside the angles. These plates serve to space the units along the angles.

After all the units are in place, the other two angles are laid on top of and bolted to the units. Then all bolts are tightened. At this point, accessories may be attached if they will not interfere with the launching.

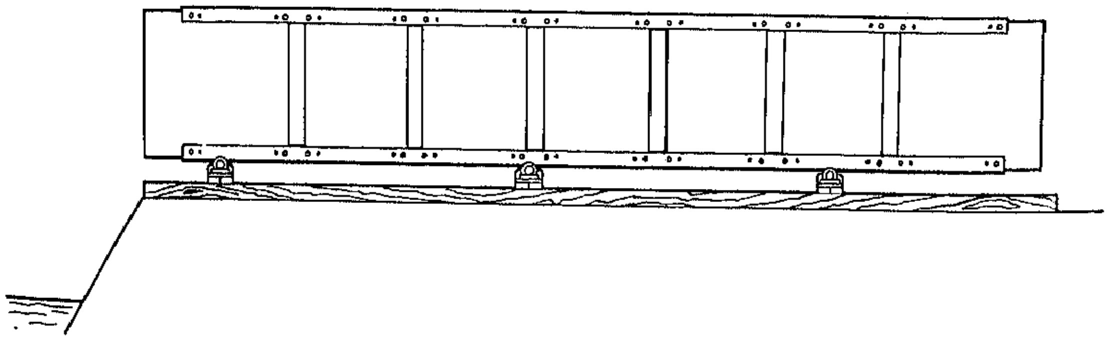


Figure 10-5.—End launching.

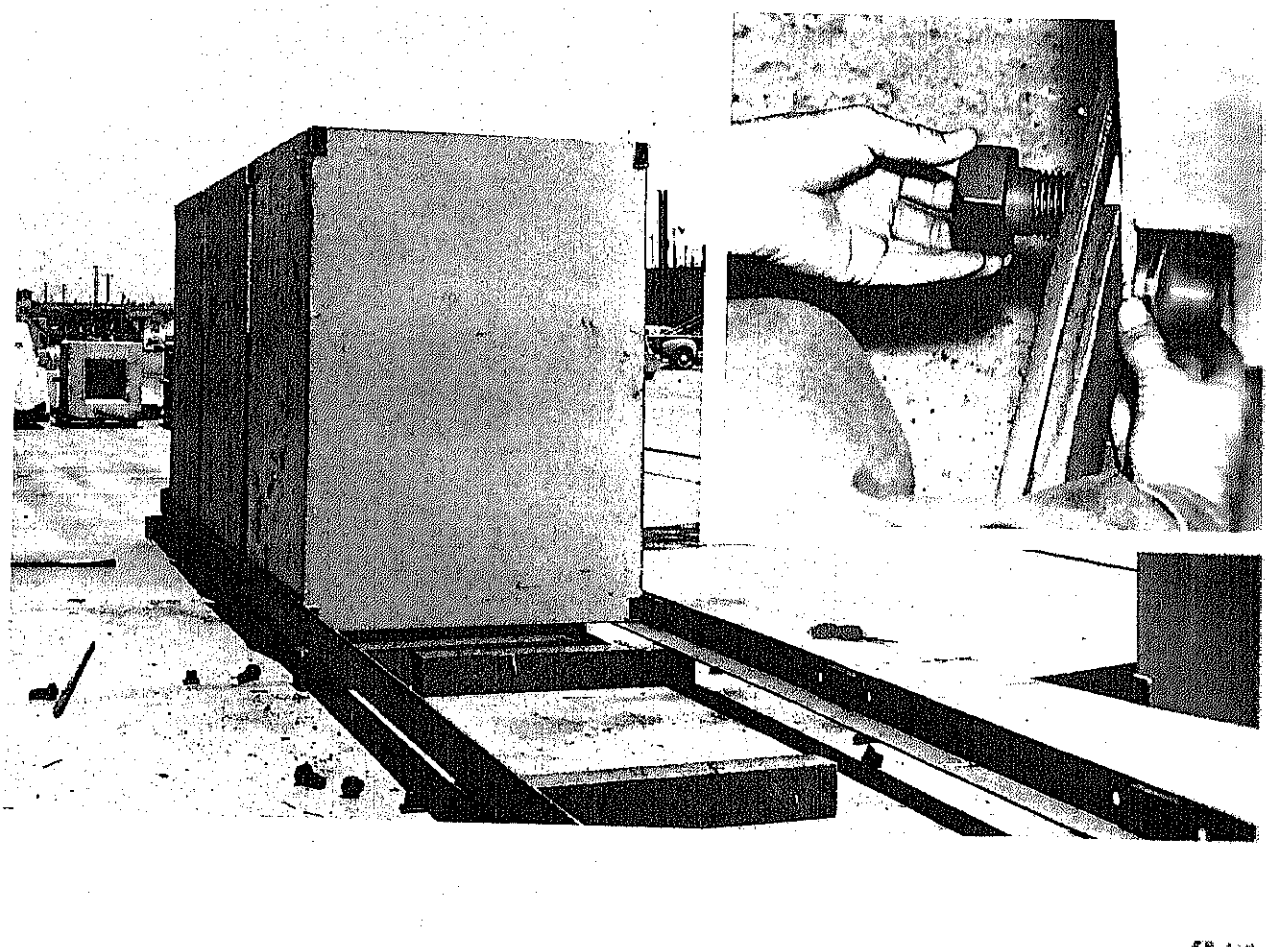
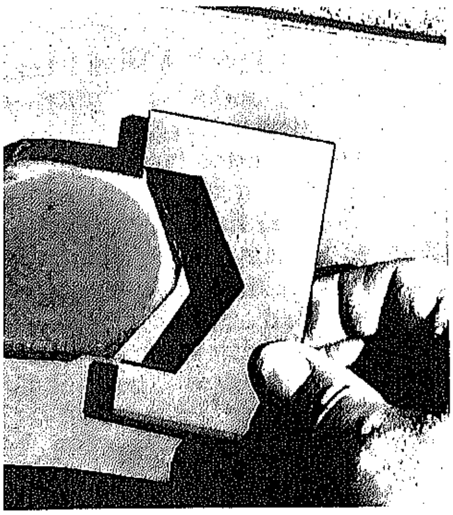


Figure 10-6.—Assembly angles, bolts, and flanged nuts.



58.119

ure 10-7.—Keeper plate.

ing a line to the string to prevent g away, the string is ready for

tring

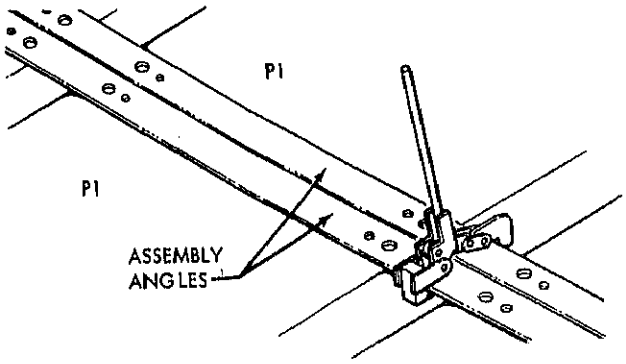
g has been assembled for a side ay be tilted into the water by jacks, illdozer, or it may be pulled in by

ng was assembled for an end anchorage is released and the string head-on into the water.

s

r more strings are in the water, they necessary, and brought alongside lt holes are lined up with whatever ailable—cranes, warping tugs, and ie strings are temporarily lashed top angle clamp shown in figure sed to force the assembly angles

the middle of the strings and work-ie ends, adjacent A6 bolts are P 1 assembly plate (figure 10-9) is holes in the assembly angles, and erted and tightened.



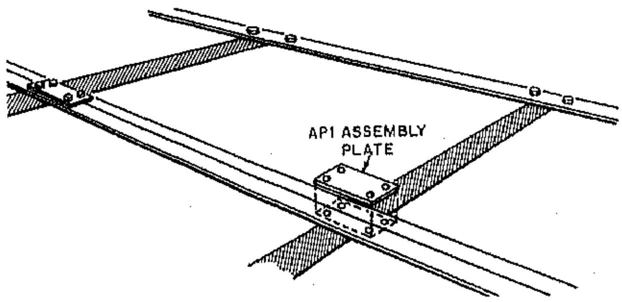
58.120

Figure 10-8.—Top angle clamp.

The strings now must be secured together at the bottom. That is done by means of tie-rod assemblies (figure 10-10). These consist of an A14B yoke and an A10 bolt at each end and a rod for each string in the structure. Three or four assemblies are needed.

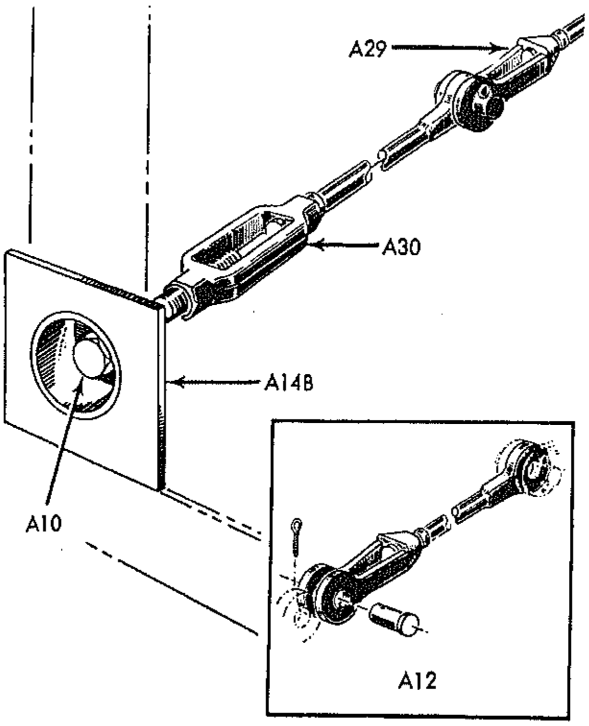
Tie rods are assembled on deck and lowered into the space between the units. They are secured just above the bilge assembly angles.

When all tie-rod assemblies are in place and tightened, the structure is flipped over, bottom side up. AP1 assembly plates are installed, and AP1 keeper plates are welded over the A6 bolt heads. Then the tie rods are removed and the structure turned right side up again. Pad eyes, cleats, chocks, and other accessories required and not previously installed are bolted or welded on deck.



58.121

Figure 10-9.—AP1 assembly plate.



58.122
Figure 10-10.—Tie-rod assembly.

CAUSEWAYS

A pontoon causeway consists of an inshore section, an offshore section, and as many intermediate sections as necessary to make up the desired length. Lengths up to 1 mile are considered possible. Each section is a 3 x 15 structure designed to support a load of 105 tons with a freeboard of 12 inches.

Each string of the offshore and inshore sections is made up of 12 P1 pontoons with a P3 sloped-deck pontoon and a P4 ramp end pontoon at one end. At the other end is an end-to-end connection pontoon—a P5F (female) end connection pontoon on the offshore section and a P5M (male) end connection pontoon on the inshore section (figure 10-11). Strings of the intermediate sections are made up of 13 P1 pontoons with a P5F at one end and a P5M at the other.

Loading

As mentioned before, causeways as well as barges normally are transported to the combat area side-loaded on an LST. To facilitate this, there is a hinge rail or shelf bracket welded on each side of the LST. A launching angle is bolted to one of the outboard strings of the barge or causeway (figure 10-12).

The LST is listed far enough to the side being loaded to permit the hinge bar of the pontoon structure to be hoisted onto the shelf bracket. Then the structure is hoisted upright, either by a crane or by the LST's own winch(es).

Inshore and offshore causeway sections always are loaded with the ramp aft and, preferably, in the after positions on the shelf bracket. These positions preclude damage resulting from waves smashing into sockets formed by the ship and forward-pointing ramps. Hoisting sequence may vary, depending on gear used and LST involved.

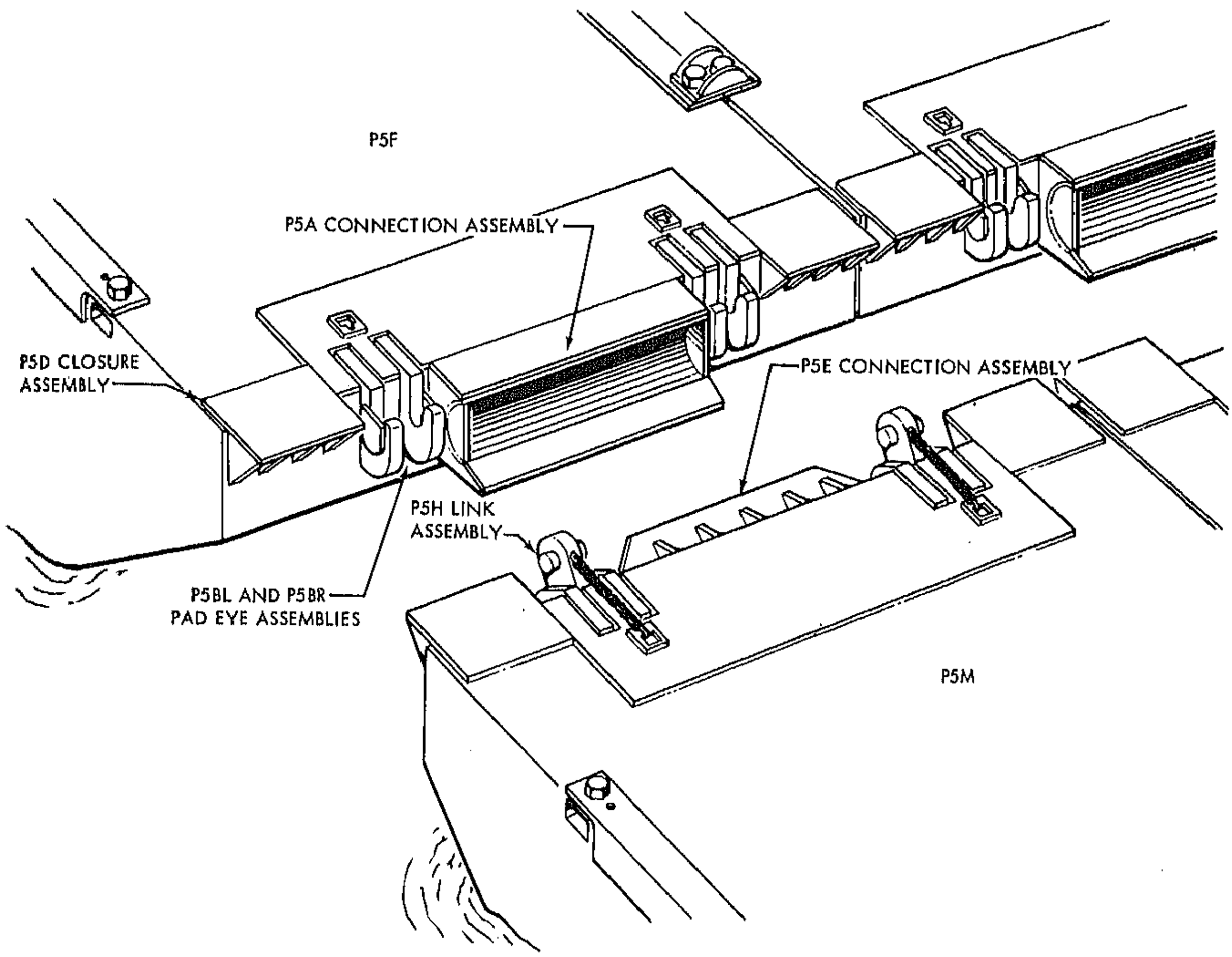
Regardless of the method used, personnel from an amphibious construction battalion, usually with a BMC in charge, bring the required gear aboard and do the job. Ship's company personnel make necessary preparations aboard ship and provide whatever assistance is required of them.

Launching

The preferred method of launching causeways is the controlled method. In that method, the hoisting tackle is left rigged after hoisting or is rerigged before launching. A strain is taken on the gear and the holddowns removed. Then the causeway section is handled in one of two ways. In the first procedure, the section is lowered until near the horizontal. Then the pelican hook is tripped, letting the section drop into the water. In the second procedure, the section is lowered until the outboard edge enters the water, at which time the hinge rail slips off the shelf bracket and the inboard edge drops into the water. Then the pelican hook is tripped.

LST-CAUSEWAY MARRIAGES

Once the causeway is beached, the marriage between the LST and the causeway is made. Modern LSTs make two types of marriages with causeways; three-point, or standoff, marriages and compression marriages.



58.131

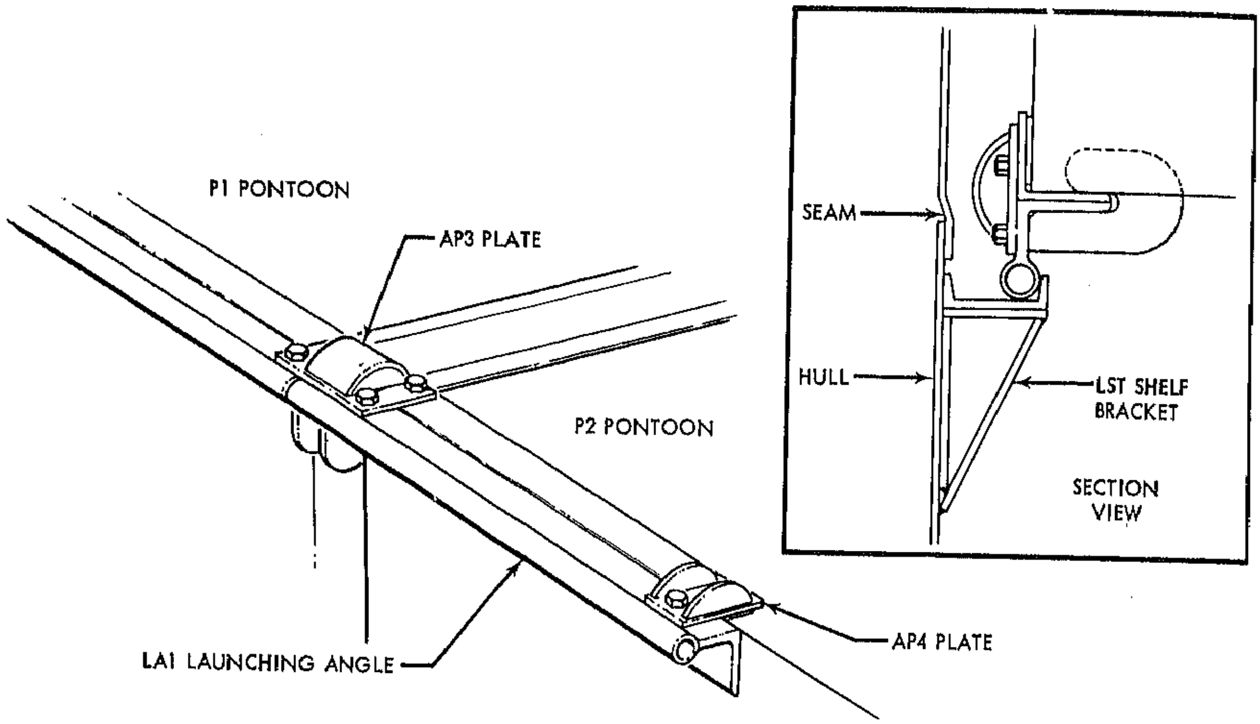
Figure 10-11.—End connection.

Three-Point, or Standoff, Marriage

The three-point, or standoff, marriage is designed to prevent the clipper bow from making contact with the causeway and is, essentially, a three-point moor. The ship has two bow-positioning winches located on the second deck. Wires from these winches are led to two 5000-pound anchors set to seaward of the causeway by the beach party. These are two points of the moor, and the positioning winches and the bow thruster are used to maneuver the bow into a position in line with the causeway. The stern anchor provides the third point of the moor and serves to hold the LST from making contact with the causeway. A snaking wire is used to haul the ship close enough to the causeway to permit the ramp to be lowered onto two chafing timbers placed to span the three center pontoons of the seaward causeway section. Two restraining wires leading through thimble chocks secure the ramp to the causeway.

Compression Marriage

Compression marriages are used only when the causeway end section is fitted with a special



58.132

Figure 10-12.—Hinge rail and launching angle.

V-shaped pudding designed to protect the clipper bow. Procedures for marrying are more or less the same as for the marriage just described, except that the bow is maneuvered to slip into the V-notch, and the LST's engines are kept turning over to hold it there.

LANDING CRAFT, UTILITY

Probably the most demanding billet for a first class or chief petty officer in the amphibious forces is that of officer in charge (OINC) of an LCU. In that billet you are charged with many of the responsibilities of the commanding officer of a ship. Frequently the LCU is called on to steam independently to distant points to deliver or pick up cargo, and in such cases you must depend on personal skill and judgment.

While the demands are great, the experience can be most rewarding. You will, of necessity, increase your shiphandling skill, sharpen your judgment, and broaden your knowledge of seamanship and related subjects. When being considered for advancement, such experience and knowledge may prove invaluable.

We will not go into detail about handling an LCU. The problems are essentially the same as for any other vessel. You should be aware, however, that the shallow draft and large sail area of the LCU make it more susceptible to the action of the wind than most craft. Another way the LCU differs from other vessels is that it has three screws and rudders. The screws operate independently, of course, but the rudders operate in unison.

LCU MARRIAGE WITH AMPHIBIOUS SHIPS

As OINC of an LCU, you will be required to make marriages with various amphibious ships. We will discuss the methods used to make a

marriage between an LCU and LST and between an LCU and LPD/LSD/LHA.

LCU Marriage With LST

The LCU-LST marriage is made with the stern gate ramp of the LST. While the LCU maneuvers into position, two 5-inch nylon positioning lines are passed from the LST to the LCU. A 6-inch nylon snaking line is passed from the tank deck of the LST to the LCU where it is rove through a snatch block shackled centerline in the LCU. The snaking line is then bent to a 15-20 foot 7/8-inch wire pendant which is passed through the rhino hole and back to the LST where it is secured to the rhino horn. The hauling part of the snaking line leads to the after snaking winch in the LST. By heaving on the snaking line and by using the positioning lines to assist in lining up the craft, the marriage is accomplished. (See figure 10-13.)

LCU Marriage With LPD/LSD/LHA

While the LCU maneuvers into position, two 5-inch nylon positioning lines are passed to the LCU. When the lines are secured, the LCU should keep engines going astern while the LPD/LSD/LHA positions the LCU using the positioning lines and wing wall capstans. When signaled, the LCU lowers the bow ramp using its engines to maintain a snug position against the marriage blocks. When the ramp is snug against the marriage blocks, the marriage is accomplished. (See figure 10-14.)

BOAT CREWS

Another responsibility of the First Class or Chief Boatswain's Mate in amphibious forces is training landing boat crews. Your crews must know seamanship, boathandling, fundamentals of engineering, communication procedures, basic navigation, weather, and gunnery. Since the crew's primary responsibility is the safe transportation of troops and cargo during the run to a beach, the crew's training and duties must focus on that goal.

Specific responsibility for the individual craft rests with the coxswain, who ensures that the crew performs its duties smartly. While in transit to a landing, the coxswain has authority over troops carried. Further, the coxswain must be an expert in boathandling and know the principles of piloting. You will find that it is no small task ensuring that your coxswains have a full allowance of boat equipment in their boats. The ship's allowance list lists the equipment each boat must have.

While each person in the craft has assigned tasks, it is absolutely necessary that each member of the crew be familiar with the duties of the others. For example, during the many amphibious landings in World War II, members of the crew were often hit by enemy fire. Since the crewmembers knew enough about each other's jobs to take over, they doubled up on their duties when another member of the crew became disabled.

BEACHMASTER UNIT (BMU)

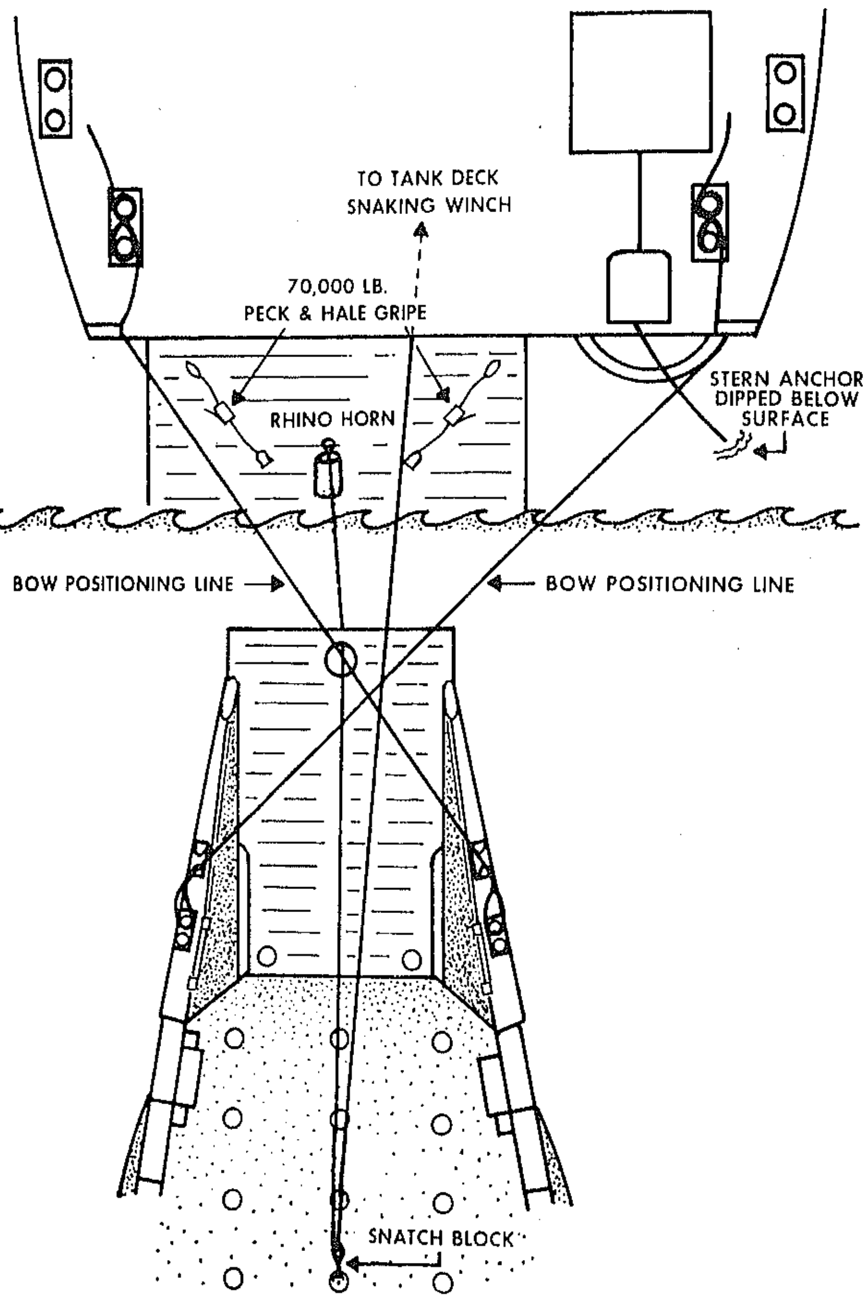
The beachmaster unit usually lands sometime between the third or fourth waves of the landing depending on the individual operation order. It forms the naval element of the shore party and, as such, is responsible for all naval functions on the beach. The tasks performed by the BMU are listed in *Boatswain's Mate 3 & 2*, NAVEDTRA 10121-G.

As a Chief Boatswain's Mate you may be the landing petty officer in the BMU; therefore, much of the responsibility for the success of the unit rests on your shoulders.

Depending on the particular operation, your duties might call for you to handle anything from the salvage detail to taking charge of a beach party group. Usually, the BMC and BM1 will find that their duties fall within the following categories:

1. Directing beach salvage operations using beach equipment and salvage boats.

2. Directing medical evacuation over the assault beach.



58.181

Figure 10-13.—Stern gate marriage (LCU and LST).

3. Directing establishment of beach defenses.
4. Directing field sanitation procedures.
5. Directing beach party passive defense in event of atomic, biological, or chemical attack.
6. Preparing a hydrographic and oceanographic (surf) report.

A completed surf report is shown in figure 10-15. The report is prepared in accordance with instructions contained in the operations order.

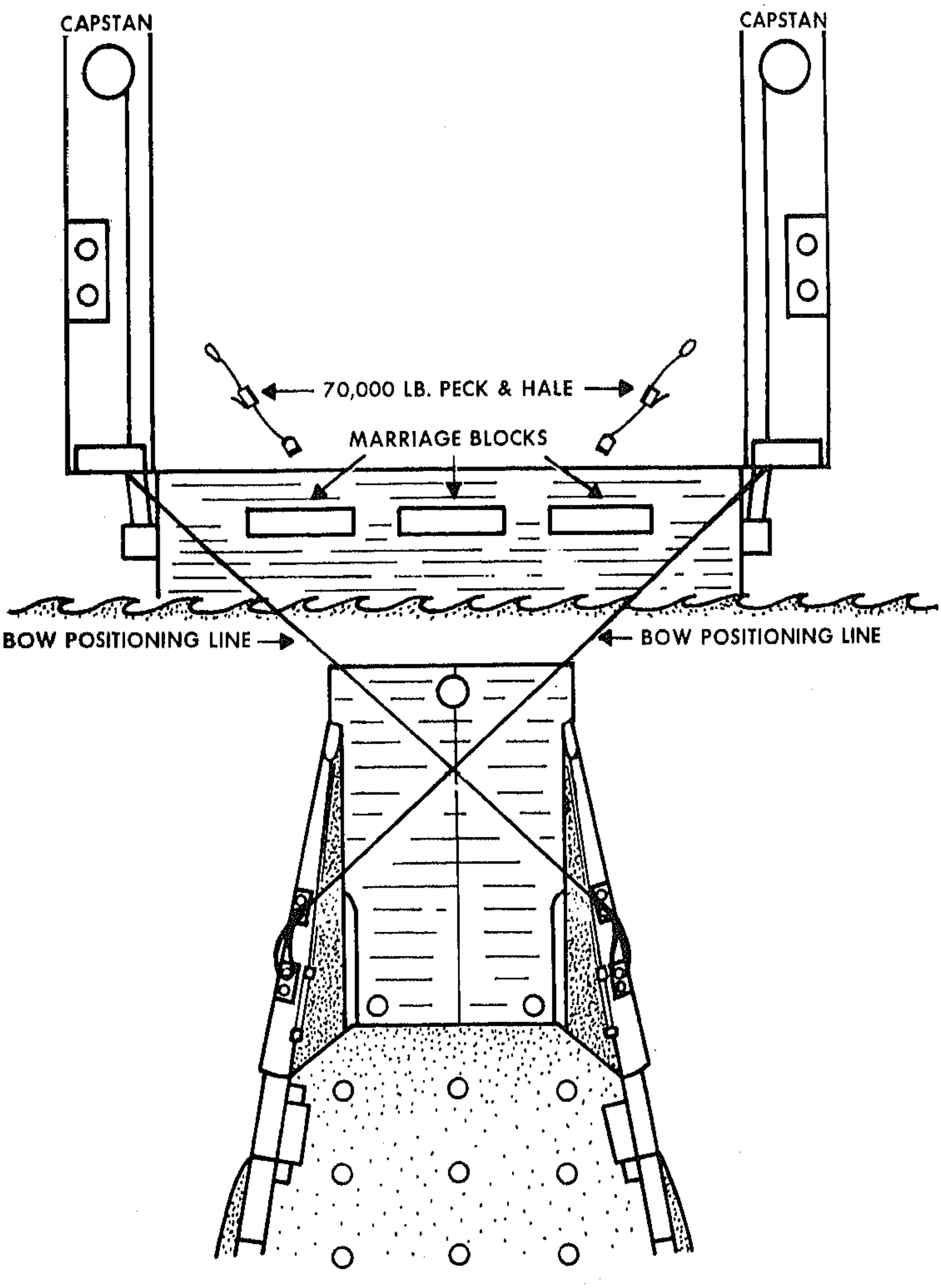


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Figure 10-14.—Stern gate marriage (LCU to LPD/LSD/LHA).

PHIBCB TWO HYDROGRAPHIC AND OCEANOGRAPHIC DATA REPORT

Beach Name	Location	Latitude	Longitude
ANZIO 3 #	LITTLE CREEK	36°	76.8°

References (Hydrographic chart, causeway or salvage report, etc.)

Date 4/23/82 Local Time 0930 Tide Stage H 3 ft. rising/falling Datum 2.1

Sea State - Wave heights in ft. (outside surf zone)

( ) Calm 0'
(✓) Smooth 1'
( ) Slight 1'-3'
( ) Moderate 3'-5'
( ) Rough 5'-8'
( ) Very Rough 8'-12'
( ) High 12'-20'
( ) Very High 20'-40'
( ) Preciptious 40'
( ) Confused ---

Wind: Velocity 15-20 Knots, Direction SW

Type breakers ( ) Spilling ( ) Plunging (✓) Surging

Breaker height, average highest 1/3rd, 1 ft. (10) Min. average)

Wave period $\frac{\text{600 Sec. (10 Min.)}}{\text{No. of waves in 10Min (86)}} = 600 =$ 6.9 Sec.

Acute angle formed by breaker crest line with shore line, 60 degrees

Littoral current $\frac{\text{Ft.}}{\text{Min.}} = \frac{(10)}{(1)} =$ .10 Knots

Surf zone width between outermost breaker and limit of wave uprush, 0 ft.
No. of foam lines. 0.

Marine life conditions on the beach(check as appropriate) ( ) Grass
( ) Seaweed ( ) Kelp beds ( ) any type marine life which would have an effect upon over the beach movement. (DESCRIBE)

Beach Material:

(✓) sand
( ) gravel
( ) pebble
( ) stone
( ) rock
( ) mud
( ) coral
( ) boulder
( ) volcanic ash

Beach Profile:

Time soundings taken 0930

Distance from waters edge. 500

Depth 15'

USE REVERSE SIDE FOR REMARKS

Figure 10-15.—A hydrographic and oceanographic data report. 58.107

CHAPTER 11

PAINTING

Painting is an expensive, time-consuming, and potentially hazardous procedure. The paint itself is costly, as are the brushes, sprayers, respirators, and associated equipment. As a supervisor, you must ensure that each painting job is done properly and safely so that maximum use is made of time, equipment, and material. Every painting assignment exposes your personnel to situations that represent potential danger to themselves and to others in the area.

PURPOSES OF PAINTING

To use paint materials and painting man-hours effectively, keep in mind the fundamental purposes of painting. The importance of each of these purposes depends, of course, on the particular surface to be painted. A brief discussion of the fundamental purposes of painting follows.

PREVENTIVE MAINTENANCE

The primary purpose of painting is protection. Protection is provided initially when a ship is built and is maintained by a sound and progressive preventive maintenance program.

Resistance to moisture from rain, snow, ice, spray, and condensation is perhaps the greatest single protective characteristic of paint. All things made of metal corrode. Moisture causes wood to swell, warp, and rot. Interior wall finishes of buildings are ruined by neglect of exterior surfaces. Porous masonry is attacked and destroyed by moisture. Paint films must therefore be as resistant to moisture as possible to provide waterproofing over the surface to which applied. Paint also acts as a protective film against attack by acids, alkalies, or marine organisms.

HABITABILITY

Habitability of ships is a concern of the Navy. Scientific tests have proved that, correctly used, color on interior surfaces has a soothing effect on the nervous system. A compartment or room painted in pastel tints is more pleasant to live in than a room painted a brilliant red or orange. It is obvious that the function of paint extends further than merely material protection.

Painting is used as a sanitary measure. A smooth, washable, painted surface which can be cleaned easily helps produce a clean and healthful atmosphere. Therefore, a painted compartment is a healthier place to live in than one that is unpainted.

Another purpose of paint is to reflect light. Used in the interior of a ship, light-colored paints reflect and distribute natural and artificial light, and thus help secure maximum efficiency from the ship's lighting system. Correct illumination helps you to do your job better and easier.

IDENTIFICATION

Another purpose of paint is the identification of objects. Red is used to identify firefighting equipment; yellow indicates caution. Color has many applications, including its use to identify compressed gas cylinders and shipboard piping systems.

THE PAINT LOCKER

Aboard ship, the paint locker is the responsibility of the first lieutenant and the Boatswain's Mate in charge. There is more to setting up a paint locker than picking out a space and moving in the

paints, brushes, and other materials. Rather, the ship's design provides for the following factors in designation of a paint locker space.

1. Availability of space.
2. Accessibility to that space.
3. Fire protection.
4. Ventilation.
5. Layout of the ship.
6. Personnel protection.
7. Amount and kinds of paints and materials to be kept in the shop.
8. Stowage of materials.

Certain spaces have been designated "paint and alcohol locker," "paint mixing and issue room," etc., and conform to the conditions set forth in *Naval Ships' Technical Manual* (NSTM) chapter 631. The flammable liquid storeroom is always located below the waterline, either forward or aft. It is so placed that it will not interfere with the engineering spaces, berthing and messing spaces, officer spaces, etc. The fire hazard and the danger from toxic vapors and fumes also are considered in selecting the location of the storeroom. Where possible, the paint stowage and paint mixing and issue rooms are adjacent but separated by a flameproof door. Adequate ventilation is provided to remove fumes injurious to health and to prevent an accumulation of flammable vapors. A built-in CO_2 or Halon 1301 total flooding systems with local and remote actuation stations are installed in addition to the small portable CO_2 extinguishers for optimum fire protection. Smoking or creating a flame in the paint locker proper or vicinity is absolutely forbidden.

The size and layout of the paint locker will be different on each type of ship. Inasmuch as space is at a premium on all naval vessels, the locker may necessarily have to be small and compact. Arrangement of installations and equipment within the locker is therefore left largely to your ingenuity in attaining maximum efficiency. In a large paint locker, provisions generally must be made for the following:

1. Shelves for stowage of paints and paint materials (in use).
2. Mixing cans.
3. Bins for wet stowage of used brushes.
4. Waste containers—one for metal discards and one for rags, paper, etc.
5. Locker stowage for mixing machine and spray guns.
6. Air compressor.
7. Spray tank (5-gallon capacity).
8. Hangers for paint and air hoses.
9. Workbench, with stools, for signpainting and lettering.
10. Remote-controlled 50-pound CO_2 fire extinguisher.
11. Portable 15-pound CO_2 fire extinguishers.

The above assumes that the bulk paint and alcohol stowage spaces are separate; if not, space within the paint locker must be provided.

MAINTENANCE

The cleanliness, orderliness, and material preservation of the paint locker are your responsibilities. The paint locker's condition and appearance will directly reflect upon your ability as a supervisor. Working with paint and painting equipment can be a messy affair, but if you ensure that your personnel exercise proper care, there will be little cleaning up to do.

Paper or some similar disposable material should be placed under and around the mixing equipment to aid in protecting the surrounding areas. All spots and splashes of paints should be cleaned from the surface on which they are spilled before they harden. If that is not done, they will have to be removed with a scraper. That means extra work. Painted surfaces should not be cleaned with solvents other than standard cleaning compounds.

The use of acids, solvents, thinners, and removers containing corrosive agents in the paint locker will bring about spot corrosion wherever they are spilled or splashed, as they destroy the paint film. Therefore, you should make frequent inspections of the space to see that corrective measures are taken to lessen or prevent corrosion. These corrective measures should be in the form of touchup painting. The area should be cleaned to bare metal, the edges of adhering paint sanded to a tapering edge, and the repainting done in such a way that the junction of the old and new paint blend as much as possible. Merely because

plenty of paint is available is no reason for a complete repaint job. The rules set forth for interior painting apply to the paint locker as well as to other interior spaces. Painted surfaces should be protected when heavy articles such as 5-gallon cans of paint and spray tanks are being moved or handled. Otherwise, the paint will be chipped or scratched, opening the way for corrosion.

Insist that all equipment be cleaned after use and correctly stowed in its designated spot. Lack of foresight in this regard results in needless expenditure of funds to replace equipment which has deteriorated or been rendered useless through lack of care, or which cannot be found.

EQUIPMENT

The amount and kinds of equipment available for the paint locker will depend on the coordinated shipboard allowance list (COSAL) for that class of ship. This equipment may include either a paint spray outfit of 5-gallon capacity, or a lightweight, portable, 1-quart capacity sprayer, driven either by air or electricity. The equipment may also include a paint mixer of the type used with a portable electric or pneumatic drill and respirators of the chemical-cartridge or mechanical-filter type.

You will have to use your own judgment as to the number of brushes to be kept available for daily use. The equipment will also include a stencil-cutting machine with supplies and several sets of metal stenciling letters.

The equipment must be properly maintained to prolong its life and to derive best results from its use. Before new paintbrushes are used, they should be rinsed with thinner. This tightens the bristles and also removes those which are loose. Brushes should not be soaked in water to tighten the bristles. The metal ferrule could rust or split due to the swelling of the wooden handle. Brushes that are to be reused the following day should be marked for white, light colors, or dark colors. Excess paint should be removed with thinner and the brushes suspended by the handle with the bristles immersed in thinner or linseed oil to just below the bottom of the ferrule. The weight of the brush must not rest on the bristles as that will cause them to become distorted. Brushes that are not to be reused immediately should be carefully cleaned with thinner, washed thoroughly with soap and water, then rinsed. They should be stored suspended from racks or laid flat wrapped in paper.

The spraying equipment used by the Navy is of very high quality and will give excellent service for years if it is given proper care. The most frequent causes of unsatisfactory operation are faulty assembly, improper adjustment, and clogging because of dirt or hardened paint. Spray equipment should be cleaned with thinner after each job or at the end of each day.

The paint supply hose should be disconnected from the tank and a container of thinner connected. Pulling the trigger will force the thinner through the paint hose and gun, which cleans out the paint remaining in them. The gun should be taken apart and each part cleaned. Care should be taken not to soak the packing or lubricated parts with thinner. That would remove the lubricant and cause the packing to become hard. The paint tank should also be cleaned with thinner and wiped dry. All the equipment should be stowed in its assigned place. The air and paint hoses should always be coiled before being stowed.

The paint-mixing attachment should be removed from the electric or pneumatic drill and cleaned with thinner. The attachment should be removed before it is cleaned, because thinner will cause the electric motor to deteriorate. Respirators used in spraypainting should be thoroughly cleaned with thinner after being used to remove the accumulation of paint. They should then be wiped with a light soap-and-water solution to remove the thinner, wiped with clear fresh water, and thoroughly dried. If left damp, the metal parts will rust and the rubber will deteriorate.

It is advisable to wipe each respirator with a diluted disinfectant solution, since more than one individual may wear it. The filters or chemical cartridges should be removed and checked after each use and renewed when necessary.

ADMINISTRATION

Successful administration of the paint locker will necessitate following a definite policy which will ensure the correct issuance of paints and paint materials and the assignment of work in accordance with your ship's instructions.

Paint Requests

Usually, each ship has its own type of paint request, but all are essentially the same. The use of this request enables you to keep a tight control over paint materials and equipment. This is necessary for the proper functioning of a ship coordinated painting program. Your BM in charge of the paint locker must never honor a paint request that has not been authorized and approved by proper authority. Figure 11-1 is an illustration of one type of paint request.

Paint requests are also necessary in maintaining a running inventory of paint and paint materials issued. This inventory provides a basis for fair allotment of paint within the ship's organization and data for the quantity and types

PAINT REQUEST

DATE 2 February 1982

NOTICE: PAINTS AND BRUSHES WILL BE ISSUED UNTIL 1000 EACH DAY EXCEPTING FIELD DAY, INSPECTION DAYS, SUNDAYS, AND HOLIDAYS. ALL PAINT AND BRUSHES WILL BE TURNED IN BY 1600 EACH DAY, UNLESS AN EXTENSION IS GRANTED BY THE FIRST LIEUTENANT.

DIV. REQUESTING 3rd WHERE TO BE USED Compt. C-301-L

AM'T & KIND OF PAINT	TYPE, SIZE, & NO. OF BRUSHES
1 gal. red lead	2 4" Flat
2 gal. gray deck	1 1½" sash
	1 3" Flat

K. Benner
RECEIVED

R. Vaughn
DIVISION OFFICER

U. Padgham
1ST LIEUTENANT

58.149

Figure 11-1.—A paint request.

of paints in short supply which need to be requested.

Work Requests

It has become a practice on many ships for the first lieutenant to establish one or more spray-painting teams. These teams are made available, as necessary, to assist other divisions. The idea, of course, is that experienced personnel can do better work in less time with the spray equipment available and, also, take better care of the gear.

Usual procedure on most ships is for a division desiring the assistance of a spray team to submit a work request to the first lieutenant.

This request is submitted by a division officer or other authorized person desiring the work to be done and contains all the data necessary for proper evaluation of the request. It may involve complete painting of several spaces or merely cutting a stencil or lettering a sign. The request is screened by the first lieutenant and must be approved before the work is undertaken. Such factors as degree of need for painting, whether touchup or a complete job, whether work conforms with Navy specifications, paint and paint materials available, and personnel available, are all taken into account in the screening process. The first lieutenant will depend on you for much of this information.

Work Schedule

You should keep a work schedule extending at least a week in advance for planning purposes. This will give you a fair estimate on how much and when additional work assignments can be accepted. It is also the basis for the daily work schedule assignment for each person in your gang so that you can use the available manpower to the best advantage. Keep your work schedule flexible so you may reassign personnel quickly. This permits maximum efficiency in the event of bad weather which precludes outside painting, equipment failure, or other unforeseen circumstances.

Attend to your paint locker assignments first. For example: One person could handle all phases of shop work which would include issuing paints, paint materials, brushes, etc. Another could mix paint, break out paint from stowage, and keep the paint locker clean and orderly. The remaining personnel should be assigned to the various jobs as are required by work requests. The work schedule should be set up in such a manner that urgent work requests receive first attention. It is not advisable to begin more work than can be completed within a reasonable length of time. Once a job is started, it should be carried on to completion.

Maintenance Requirements

The kinds of paint materials kept on hand for daily maintenance work will usually include the following:

1. Machinery gray enamel.
2. Light green.
3. Inside white.
4. Red deck.
5. Green deck.
6. Zinc chromates and red lead.
7. Varnishes.
8. Thinners.
9. Striping paints.
10. Stencil paint and ink.
11. Linseed oil.
12. Aluminum pigment.
13. Outside hull paints to conform with the color used on the hull.

Stowage

The heaviest containers of paint, such as 5-gallon and 1-gallon cans, should be stowed closest to the deck. This will ensure that the top shelves or bins are not excessively loaded, and there will be less chance of their giving way. Paint cans should be stowed with the labels visible so selection of the type of paint desired will be easier. The paint most generally used should be stowed in the front of the bins, and less frequently used paints in the back. The oldest paints should always be used first, as paint tends to deteriorate with age. Containers of paint should be upended about once every 3 to 4 months to prevent the pigment from settling to the bottom of the can and becoming caked, resulting in extra work when the paint is mixed. Paint should not be left standing in open containers, as a scum will form over the surface and the paint will deteriorate due to evaporation.

Paint that has been thinned should never be mixed with paint not thinned. If this precautionary measure is not observed, there will be an excess of thinned paint on hand. It is well to remember that practically all the paints used by the Navy come ready to use, and not many paint jobs will require thinned paint.

Paint Locker Safety

Paint lockers are equipped with various safety items to protect both the personnel working inside the space and the space itself. Fire protection is provided in the form of either CO_2 or Halon 1301 total flooding systems. One or more 15-pound CO_2 extinguishers may also be provided for added protection. In conjunction with the fixed systems, a set of alarms, both visual and audible, are installed to warn personnel of the actuation of the systems. Depending on the location of the paint locker, a time-delay device may be installed in the flooding system discharge to allow personnel adequate time to vacate the space upon actuation of the system. High heat sensors set at 125°F are installed in the overhead of the paint locker. They are connected to the heat temperature alarm on an I.C. panel in damage control central or the I.C. shop. The supply and exhaust ventilation should be running at all times. Compartments fitted with CO_2 or Halon 1301 smothering (flooding) systems or compartments subject to contamination by heavier-than-air vapors shall have exhaust terminals 9 inches above the deck. Operating and safety precautions for the installed fire protection systems are to be posted at the local and remote actuation stations. Also posted at the local actuation station shall be a placard showing the location of the vent controllers and the location of the vent valves serving the paint locker. Lighting fixtures in this type of space are to be of the explosion-proof type and properly maintained.

Where possible, all paint, paint thinner, and drier containers should be kept sealed. Zinc in dust-zinc oxide containers, however, should have a pinhole in the lid to permit the escape of the hydrogen gas generated by this paint. Otherwise, the container might explode. Alcohol should be kept in a locked space at all times.

If canvas is used to protect the deck from splashes and drops of paint, thinners, driers, etc., it should be thoroughly dried before being stowed. Otherwise, a fire may result from spontaneous combustion. The protecting canvas should be fireproofed before being used.

Used rags should be kept in a metal container and disposed of at the end of the working day. Never allow rubbish to accumulate in the locker, because there is always danger of spontaneous combustion. The locker should be thoroughly cleaned and all materials properly restored to their correct stowage bins at the end of the day.

As the supervisor of the paint locker, you should be familiar with the composition of paint materials and their toxic properties. The chief health hazards in a paint locker are—

1. Mists of pigments and thinners.
2. Vapors of paint driers, thinners, etc.
3. Corrosive agents in paint removers.
4. Dust created in mixing dry pigments such as zinc dust.
5. Clothing that is spattered with paint, thinner, driers, removers, etc.

It is your responsibility to instruct the personnel under your supervision in the correct methods of handling paints and paint materials. Always insist that they wear clean clothing. This will prevent absorption of toxic materials and prevent skin burns and irritation.

In spite of all instructions to the contrary, many persons continue to use paint thinner to remove paint from their hands, faces, and other parts of their bodies. This practice is dangerous because the thinner can be absorbed through the pores. You can reduce their inclination to use thinner if you provide them with white petrolatum to smear on exposed parts of their bodies before beginning to paint. Paint spots then can be cleaned off with a rag. Stubborn spots generally will yield to rubbing with more petrolatum. There also is a waterless type of hand cleaner that is excellent for this purpose.

Plenty of fresh air is a primary requisite in a paint locker, as it prevents an overaccumulation of poisonous vapors and dust. If the mechanical ventilation system does not provide an adequate supply of air, portable electric blowers should be used to supply additional ventilation.

GENERAL SAFETY PRECAUTIONS IN PAINTING

As a supervisor, safety of your personnel is one of your prime responsibilities. Lay out the work and manage projects in such a manner as to produce the safest possible conditions. Ensure that your personnel are informed of all safety rules. Be certain they understand them, and insist they follow them. Painting aboard ship should be done under the direction of experienced personnel. Lack of training and lack of knowledge of hazards produce a possible threat to the safety of the crew.

The equipment and precautions which follow apply to all phases of painting operations, including cleaning, chipping, scaling, and sanding, as well as painting.

SAFETY EQUIPMENT

Life or health may depend on the availability and proper functioning of safety equipment used in painting. We will discuss the most common safety equipment used aboard ship.

Life Jackets

Life jackets must be worn when working in positions near or over water. A safety harness and tending lines must also be used. Tending lines should be of such length (no more than 2 feet of slack) that the jolt from a fall will not cause injury.

Respirators

Personnel must wear the proper type of face mask in surface preparation and painting. The most important types of respirators are the following:

1. Dispersoid respirators for protection against dust present when sanding. These respirators contain filters only.
2. Chemical cartridge respirators for protection against fumes and solvent vapors. These respirators contain activated carbon cartridges which absorb the fumes or vapors.
3. Supplied air respirators for use in closed areas where ventilation cannot be supplied.

Respiratory equipment must be cleaned immediately after use and be properly maintained and stored in clean, dry compartments. Filters, cartridges, and rubber parts should be inspected before each use and at regular intervals for signs of deterioration. Any suspect filter or cartridge should be replaced immediately.

Eye Protection

Safety goggles must be worn in areas where there is any possibility of dust, fumes, or solvents touching the eyes as may occur when blasting, sanding, or spraying. They must be kept clean and readily available. They should fit well, contain lenses of unbreakable glass or plastic, and allow adequate peripheral as well as straight-ahead vision.

Protective Clothing

Personnel should wear clean clothing which covers them as much as possible to avoid skin contact with painting or cleaning materials. Painting operations often require the use of solvents, acids, or alkali cleaners, some of which are irritating to the skin. Steel-toed safety shoes with nonskid rubber soles should be used when working in enclosed spaces or where flammable vapors may be present.

ENCLOSED SPACES

Do not allow your personnel to enter any enclosed or poorly ventilated space until a gas-free engineer has certified that the space is free of suffocating, poisonous, and flammable gases. Insist on the use of the buddy system when your personnel are working in a hazardous area, such as tanks. At least two persons should be assigned to such jobs and each should be in communication with the other at all times. If one should have an accident, the other can seek aid or come to his or her aid. If an accident involves a tank or other confined space, the person on the outside must seek help. This person MUST NOT ENTER THE TANK ALONE to give assistance. All too frequently multiple deaths have occurred from failure to follow this basic precaution. The buddy system is designed to seek aid. Whenever this system is necessary, safety harness and tending lines should be used.

CHAPTER 631, NAVAL SHIPS' TECHNICAL MANUAL

NSTM chapter 631 governs all painting done in the Navy. Included are instructions for painting and other measures to prevent corrosion on ships and boats in service, such as:

1. When and how often to paint.
2. Thickness of paint film.
3. Material and methods for surface preparation.
4. Material and methods for application of paint.
5. Tables listing paints and paint systems to use on various surfaces.
6. Instructions for painting distinguishing numerals and letters and special markings, awards, and insignia.
7. Discussion on paint failures.

CHAPTER 12

AGE CONTROL ORGANIZATION

one of the duties of the
ıg. As a BM1 or a BMC,
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'our ship. Your work in
quire you to demonstrate
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d to organize and super-
nage control parties; plan,
damage control exercises;
personnel in all phases of
must have a thorough
portable and stationary
nent.
ıanual *Boatswain's Mate*
1 21-G, covers firefighting
ıipment, so those subjects
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r party and the duties of
pair party.
phase of damage control
e before damage occurs.
xercises, tests, and inspec-
personnel acquire the
perform when needed.
intensive damage control
when the ship is sinking.
bjectives of shipboard

ible preliminary actions
such as maintenance of
ntegrity, preservation of
stability, removal of fire
nd distribution of emer-

localize such damage as
ns as control of flooding,
and buoyancy, combating
nent of personnel.

3. To accomplish emergency repairs or restorations as quickly as possible after damage occurs by such actions as supplying casualty power, regaining a safe margin of stability and buoyancy, reinforcing damaged structures, and manning essential equipment.

The ship's ability to inflict punishment and destroy the enemy may depend on the effectiveness of damage control procedures. Every member of the ship's company must recognize his or her responsibility and its importance. Damage control is an offensive as well as a defensive function.

ORGANIZATION OF A REPAIR PARTY

For a repair party to function effectively in the control of battle damage, personnel must be assigned to specific functions and duties. Some personnel may have more than one assignment, depending on the number and qualifications of personnel available.

It is not enough that your personnel read about how to make repairs, study pictures of equipment, or discuss methods. Nor is it enough that they have all the tools authorized by the ship's allowance list, or that they make all the prefabricated patches and tools as may be suggested. Damage control personnel must know how to apply principles and use materials effectively. This knowledge can be gained by education, training, and actual practice.

A thorough knowledge of the ship is of prime importance. Repair party personnel must know their own area along with the areas of other repair parties in case they have to make repairs or assist the other repair parties in their area. It is

recommended that personnel be exchanged between repair parties from time to time so they may train and drill in other areas.

The information that follows sets forth the basic organization of a repair party.

REPAIR PARTY LEADER

The repair party leader is the person in charge of the repair party. In addition to carrying out all orders from damage control central, the repair party leader is responsible for—

1. Assigning repair party personnel to form an effective damage control and damage repair group.
2. Instructing repair party personnel in damage control duties and the operation and use of damage control equipment.
3. Ensuring that the performance of the repair party is in accordance with current instructions and safety precautions.
4. Ensuring that repair party equipment is kept in the proper state of stowage, cleanliness, and maintenance.
5. Ensuring that training records of repair party personnel concerning damage control training are properly maintained.
6. Ensuring that all status boards and message logs at the repair station are properly maintained and that damage control central is kept informed.
7. Coordinating the efforts of the repair party with other repair parties.
8. Striving to correct any damage sustained and to maintain the ship in fighting condition by using personnel assigned and equipment provided in the most effective manner.

SCENE LEADER

The scene leader is the assistant repair party leader and is in charge of the repair locker in the absence of the repair party leader. The scene leader—

1. Takes charge of all actions at the scene, directing the efforts of the repair party effectively against fires, flooding, and structural damage.
2. Keeps the repair party leader informed of all items of damage discovered and action taken.
3. Ensures that personnel observe all safety precautions and use standard procedures in the performance of all evolutions.
4. Ensures that all equipment is used correctly and that safety precautions are observed.

#1 OBA MAN

The #1 OBA man is the primary investigator. When there is a hit or a near-miss, he or she will investigate the repair party area for damage and will report to the repair party leader. When there is a fire, the #1 OBA man will be the nozzleman on the #1 hose team.

#2 OBA MAN

The #2 OBA man is the secondary investigator. The duties are the same as those of the #1 OBA man with the exception that he or she is the nozzleman on the #2 hose team when there is a fire.

REPAIR PARTY ELECTRICIAN

The repair party electrician is responsible for deenergizing and reenergizing electrical circuits as required. He or she is also responsible for the rigging of casualty power.

MESSENGER

The messenger accompanies the #1 OBA man on the preliminary investigation. When the firefighting team goes into action, the messenger carries messages and reports from the scene leader to the repair party leader.

The remainder of the repair party personnel will be assigned duties at the discretion of the repair party leader.

FIREFIGHTING

To some extent, the procedures for fighting a shipboard fire depend upon the conditions under which the fire occurs. Fires that occur during action, normal steaming, or when a full crew is on board are handled as a battle casualty and the ship will go to general quarters. These fires, which

may occur in port or at sea, are normally fought by the firefighting party from the repair station in that section of the ship. The fires are fought under the direction of damage control (DC) central (via the air officer, for fires in aircraft and aircraft parking areas).

On larger ships, it may not always be feasible to go to general quarters. In these cases, a nucleus fire party will be organized to handle fires. The nucleus fire party is made up mainly of personnel from R-Division and should include a qualified electrician, hospital corpsman, and a Gunner's Mate. Those personnel assigned to the nucleus fire party will not be assigned to the underway watchbill. The nucleus fire party will respond to the emergency immediately when the fire alarm is sounded and proceed to the scene of the fire with their assigned equipment. The repair locker in the vicinity of the fire will be manned to back up and assist the nucleus fire party with equipment that is needed. If the nucleus fire party is unable to bring the fire under control, then the ship will go to general quarters.

When a fire or other emergency occurs in port and there is only a partial crew on board, the duty repair party will handle the situation. In the information that follows, the organization and actions of the regular firefighting party and the duty repair party are described in detail.

ORGANIZATION OF A FIREFIGHTING PARTY

Every firefighting party consists of two hose teams. The #1 hose team is the attacking fire team and the #2 hose team is the backup team. When sufficient personnel are available in a repair party, the firefighting party will consist of personnel from the repair party. On small ships where insufficient personnel are available in one repair party to organize two hose teams, the #1 hose team will be made up of personnel from one repair party and the #2 hose team will be made up of personnel from an adjacent repair party.

The organization of repair parties and firefighting parties will be in accordance with the provisions set forth in the ship's emergency bills. Personnel assignments and duties may vary slightly from ship to ship.

The organization of a firefighting party is shown in figure 12-1. At times an individual will have to perform more than one duty. That must be considered when organizing a firefighting party.

Scene Leader

The scene leader is directly in charge of the firefighting party. The first duty of the scene leader is to get to the fire quickly to investigate and evaluate the situation. When the nature of the fire has been determined, the scene leader will decide what type of equipment to use and will inform damage control central (via the repair party leader, when the firefighting party is from a repair party). Later developments may require the use of different or additional equipment, but the scene leader must decide what to use first.

Nozzlemen

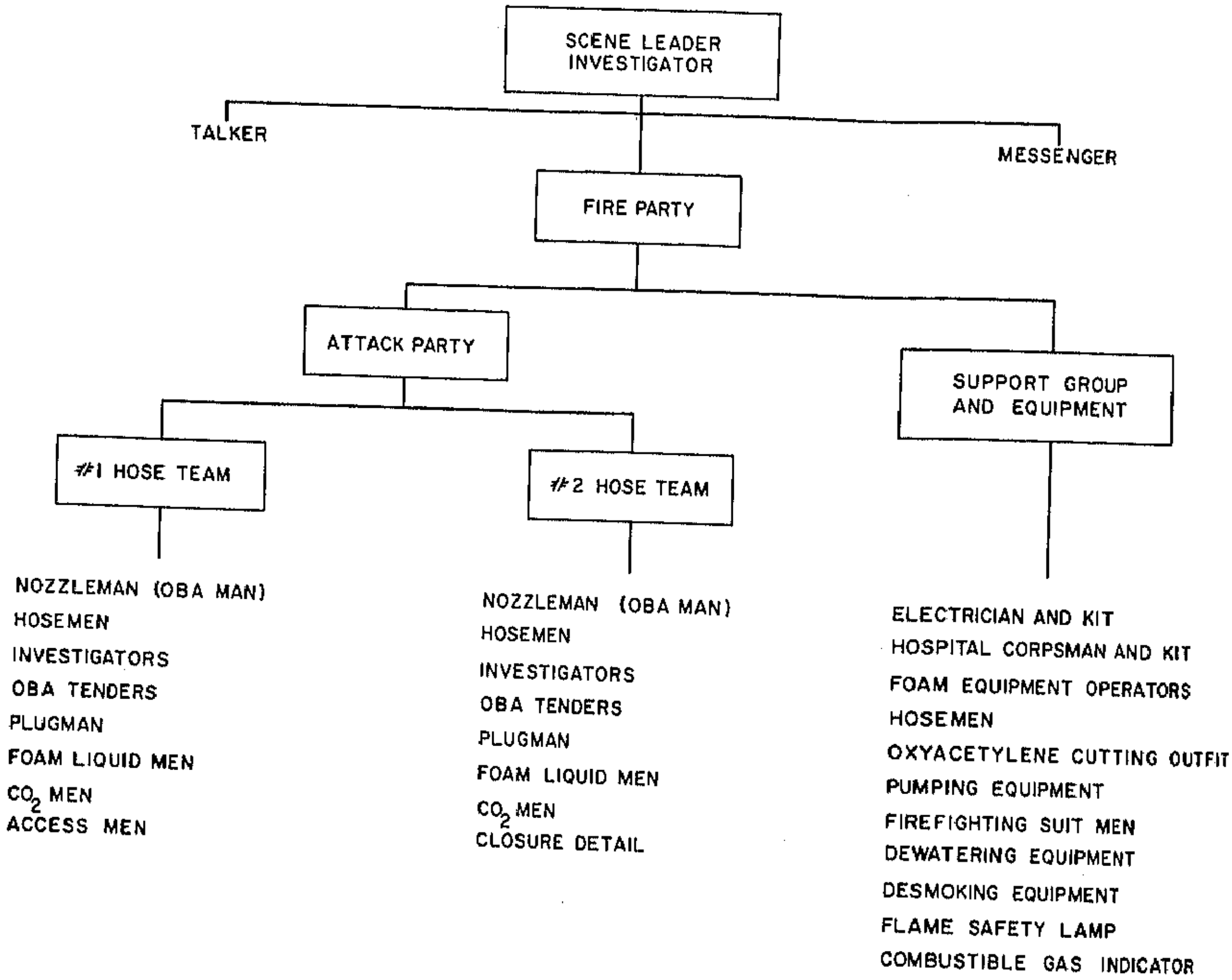
The nozzlemen (OBA men) will have their OBAs on and ready for immediate use at all times during firefighting operations. They assist the scene leader with the investigation of the fire when the oxygen breathing apparatus (OBA) is needed for entry in a compartment. The nozzlemen will man the all-purpose nozzle and the applicator during firefighting operations. They will be in complete battle dress, with gloves and miner's headlamp.

Hosemen

The hosemen lead out the hose from the fireplug, remove kinks and sharp bends, and tend the hose. The hosemen will wear OBAs when fighting the fire. The number of hosemen assigned to a fire party varies in accordance with the number of personnel available and the size of the firehose. At least three persons (nozzleman and two hosemen) are required for a 1 1/2-inch hose, and four or five persons (nozzleman and three or four hosemen) are required for a 2 1/2-inch hose.

Investigators

The investigators set the fire boundaries established by DC central by removing burnable materials from bulkheads and cooling down



8.80(185)

Figure 12-1.—Organization of a firefighting party.

the bulkheads if needed. They will also investigate the area for further damage, take soundings, and lead personnel trapped in smoke-filled compartments to safety.

OBA Tenders

The OBA tenders are in charge of tending lines (when used) and keeping spare canisters readily available.

Plugman

The plugman stands by to operate the fireplug valve when ordered. He or she rigs and stands by jumper lines, and clears the fireplug strainer when necessary.

Access Men

The access men open doors, hatches, scuttles, and other openings, and clear routes as necessary to gain access to the fire. These persons carry the equipment necessary to open jammed fittings and locked doors.

Foam Supply Man

The foam supply man prepares the foam equipment for operation and operates it as

required. He or she takes spare foam cans from racks and prepares them for use.

CO_2 Supply Men

The CO_2 supply men take extinguishers to the fire.

Closure Detail

The closure detail secures all doors, hatches, and openings around the fire area to isolate the fire. The detail secures all ventilation closures and fans in the area of smoke and heat and establishes secondary fire boundaries by cooling down the nearby areas.

Electrician

The electrician deenergizes and reenergizes electrical circuits in the fire area as required, both for the protection of firefighting personnel and the possible prevention of explosions or flashbacks. He or she rigs power cables as required for portable tools, lights, and blowers.

Hospital Corpsman

The hospital corpsman will render first aid to the injured at the scene and supervise the moving of the seriously injured to sickbay for more extensive treatment.

Telephone Talker

The sound-powered telephone talker plugs into the nearest JZ circuit to establish and maintain communications with damage control central, either directly or through the local repair party.

Messenger

The messenger carries the written messages from the scene leader to the repair party leader.

Other personnel and equipment assigned to a firefighting party are foam equipment operators, additional hosemen, firefighting suit men, oxyacetylene cutting outfit, pumping equipment, dewatering equipment, desmoking equipment, oxygen indicator, and combustible gas indicator.

FIREFIGHTING PARTY IN ACTION

To make the most effective use of the personnel and equipment in your fire party, you must be able to make a rapid analysis of the situation. Since no two fires are alike, the deployment of personnel and equipment will not always be the same. However, the following general rules will be helpful in most situations:

1. Do not underman the attacking party, which is the first line of defense. The attack group makes the primary investigation and moves in to contain the fire.
2. Use the support group to bring up auxiliary equipment, assist with foam and CO_2 supply, and fight the fire as needed.
3. See that the fire party is quiet and orderly. There should be only two persons talking at a fire—the scene leader and the JZ talker who makes reports to damage control central.
4. Give concise and accurate orders.
5. Make concise and accurate reports to damage control central.
6. Observe all safety precautions and insist that personnel in the fire party also observe them.
7. Do not overlook the possibility that the fire may spread by radiation, conduction, or convection. Establish fire boundaries by stationing personnel in adjoining compartments to check on the possibility of ignition. Have the personnel cool down bulkheads and deck as necessary.

In fighting any fire, remember that your first problem is to get personnel and equipment to the fire. Firefighting is not a "by-the-numbers" affair and different situations may require different action. After a fire has been reported and the location and class established, the following procedure is generally used:

1. Isolate the fire. Close all doors, hatches, and secure ventilation.
2. Deenergize all electrical circuits in the area where the fire is located.
3. Bring required equipment to the scene of the fire (CO_2 extinguishers, dry powder extinguishers, applicators, fire rake, oxygen indicator, combustible gas indicator, and dewatering equipment).
4. Lead out two hoses from different plugs to the area of the fire. Rig one hose with an

applicator, and charge both hoses. If the fire is belowdecks, only 1 1/2-inch hoses should be used.

5. There must be an OBA man in complete battle dress, with gloves and miner's headlamp, serving as nozzleman for each of the two separate hoses.

6. Run out extra hoses in surrounding compartments to cool off decks, overheads, and bulkheads.

7. Rig portable pumps for use if firemain pressure is lost.

8. Station personnel to protect combustibles in the area (at magazine sprinklers or CO_2 releases).

9. Combat the fire from the best position possible to protect personnel. Approach a topside fire windward, if possible.

10. Send out investigators to check surrounding area. Inspecting and reporting must continue until the fire is out and danger is over. Then investigators return to the scene leader.

11. Move phone talker as close to the scene as possible.

12. The reports to be made from the scene are as follows:

a. Location of fire.
b. Class of fire.
c. Action taken in combating the fire.
d. Fire under control.
e. Fire out.
f. Reflash watch set.
g. Compartment tested for explosive gases.
h. Compartment tested for oxygen content.
i. Fire overhauled.
j. Electrical circuits and ventilation system tested.
k. Amount of damage.

Message Drafting

Reporting damage and plotting reports on diagrams for visual display can be done quickly and accurately by using a simple legend system. An effective legend system is covered in *Naval Ships' Technical Manual*, Chapter 079, Volume 2. The legend system is used on written messages, by phone talkers, and by investigators, and for marking status, casualty, and stability boards.

Methods of Approach

Studying the detailed information contained in chapter 555 of *Naval Ships' Technical Manual* and relating it to the experience gained in Navy firefighting schools will help increase the knowledge and proficiency of the firefighter. Of course, a firefighter does not just hurry to a fire and engage in the work of extinguishing it according to a blueprint or formula. On the contrary, it may be necessary to make split-second changes in techniques or methods of extinguishing the fire as the fire changes its pattern.

Basically, the firefighter must determine three things immediately before going into action: the location, the type, and the extent of the fire—that is, its immediate and potential effects on the surrounding areas.

Information concerning the location of the fire would probably be supplied by the investigators from the repair party or by the officer of the deck (for fires to be handled by the duty repair party). The firefighter should have sufficient knowledge of the construction and compartmentation of his or her ship to be able to visualize the location of the fire and the location of firefighting equipment (such as fireplugs) relative to the fire. The firefighter must know the classification of fires so that he or she can decide quickly what methods to use to extinguish it.

In determining the extent of the fire and deciding what conditions will be produced by the fire, the firefighter must take the whole situation into account and decide what effect the fire is having on any surrounding area. He or she may discover that there are two or three fires to extinguish and that they are not fires of any single class. He or she may discover that the fire is being supplied with air from ventilating ducts, and that it is exhausting noxious fumes into living compartments. He or she may find that the fire is proceeding along channels leading to more combustible substances and that more hoses and nozzles are needed.

The firefighter must be familiar with the performance characteristics of the all-purpose nozzle in all positions. The table shown in figure 12-2 has been prepared to serve as a guide when estimating various nozzle discharge capacities and characteristics. All figures used in the table are approximate, and all are calculated for still air.

N.A.P. NOZZLE			STRAIGHT STREAM		HIGH-VELOCITY FOG			LOW-VELOCITY FOG		
SIZE (IN.)	ORIFICE (IN.)	PRESSURE (PSI)	DISCHARGE (GPM)	REACH (FT.)	DISCHARGE (GPM)	REACH (FT.)	DIAMETER (FT.)	DISCHARGE (GPM)	REACH (FT.)	DIAMETER (FT.)
1 1/2	5/8	70	97	65	54	25	6	46	8	14
2 1/2	1	83	273	75	110	35	8	107	8	20

103.88

Figure 12-2.—Discharge characteristics for all-purpose nozzle.

To use the table, select the appropriate nozzle size from the first column. Then move horizontally to the right until you are under the proper discharge pattern title (STRAIGHT STREAM, HIGH-VELOCITY FOG, or LOW-VELOCITY FOG). Reading the figures listed under the subtitles (SIZE, ORIFICE, PRESSURE, DISCHARGE, REACH, or DIAMETER) will provide the desired information.

The person in charge of a firefighting party must ensure that the fire party does not sink the ship in the course of putting out the fire. A standard Navy 2 1/2-inch nozzle with a 1-inch orifice, operating at 100 psi nozzle pressure, will deliver over a ton of water a minute. Remember that all water pumped into the ship must be drained or pumped out again, and that (particularly on a damaged ship) it must be done quickly to prevent a critical impairment of stability. The judgment which the firefighter must use under all conditions repeatedly tests his or her resourcefulness and skill.

ORGANIZATION OF THE DUTY REPAIR PARTY

The in-port repair party is composed primarily of personnel in the regular damage control repair parties, with each duty section having an effective firefighting force. Heads of departments, division officers, and leading petty officers concerned must consider training and experience of repair party personnel in making assignments in accordance with the General Emergency Bill. Take care not to assign personnel of the in-port duty repair fire party to additional details in the rescue and assistance party or to other special duties in port which require absence from the ship. There are enough personnel assigned to the duty repair party to make up firefighting and damage control teams to handle emergencies. Additional assistance is provided by personnel not assigned who muster at quarters or a designated place provided according to the ship's organization. When directed by the command duty officer or by competent authority, additional personnel are dispatched to the scene as required.

When the alarm is sounded, personnel take stations and perform duties as shown in table 12-1.

DUTY REPAIR PARTY IN ACTION

When the duty repair party is called away, it may be for fire, flooding, collision, and so forth. To make effective use of personnel and equipment available, the duty repair party must be trained to handle any given situation.

In the case of an in-port collision, the 1MC must be used to alert the duty repair party by sounding the alarm and giving the location of the collision—such as, frame 54, portside.

The following procedures must then be carried out by the duty repair party:

1. Scene leader must speed to the scene to make a rapid analysis of the situation, so as to make effective use of the available personnel and equipment.
2. Personnel must report to the scene of damage quickly with the assigned equipment.
3. Flooding boundaries must be established and maintained as soon as possible. Condition ZEBRA must be set on all accesses at least ten

Table 12-1.—Station and Duties of In Port Duty Repair Party Personnel

Personnel	Station	Duties
Command Duty Officer	Scene	In general charge.
Damage Control Duty Officer (Officer in Charge)	Scene	In direct charge of operations.
Engineering Department Duty Officer	Engineering control	Maintain prescribed pressure on firemain. If directed, make preparations for getting ship underway.
Duty Repair Officer (or Petty Officer)	D.C. Central	Maintain communications with duty repair party, receive reports on status, coordinate assistance from repair party personnel as required and keep OOD informed of pertinent information.
Medical Department Petty Officer	Scene	Render first aid as necessary.
Supply Department Petty Officer	Scene	Open storerooms as directed.
Log Room Duty Yeoman	D.C. Central	Provide and man 2JZ phones.
Duty Repair Party Personnel	Equip at designated lockers	Duty repair party personnel, proceed to scene and take necessary action.
All Other Personnel	Quarters	Stand clear. (Stand by to assist as directed by Command Duty Officer.)

8.79.0

frames forward and aft of the collision, closing all athwartship doors first.

4. Communications must be established promptly with the quarterdeck and DCC.

5. Manned and ready report must be sent to OOD and DCC as soon as personnel arrive at the scene with the minimum of necessary equipment.

6. Investigation of damage must start as soon as possible in the immediate area and adjacent compartments, including the sounding of tanks in the vicinity.

7. Complete and correct information must be eported to OOD and DCC.

8. Proper procedures for rigging and using quipment must be followed.

9. Personnel must make emergency repairs such as cutting, plugging, and pipe patching.

Personnel must also rig pumps, dewater compartments, and shore as circumstances require.

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BOATSWAIN'S MATE 1 & C

NAVEDTRA 10122-E

Prepared by the Naval Education and Training Program Development Center, Pensacola, Florida

Your NRCC contains a set of assignments and perforated answer sheets. The Rate Training Manual, Boatswain's Mate 1&C, NAVEDTRA 10122-E , is your textbook for the NRCC. If an errata sheet comes with the NRCC, make all indicated changes or corrections. Do not change or correct the textbook or assignments in any other way.

HOW TO COMPLETE THIS COURSE SUCCESSFULLY

Study the textbook pages given at the beginning of each assignment before trying to answer the items. Pay attention to tables and illustrations as they contain a lot of information. Making your own drawings can help you understand the subject matter. Also, read the learning objectives that precede the sets of items. The learning objectives and items are based on the subject matter or study material in the textbook. The objectives tell you what you should be able to do by studying assigned textual material and answering the items.

At this point you should be ready to answer the items in the assignment. Read each item carefully. Select the BEST ANSWER for each item, consulting your textbook when necessary. Be sure to select the BEST ANSWER from the subject matter in the textbook. You may discuss difficult points in the course with others. However, the answer you select must be your own. Remove a perforated answer sheet from the back of this text, write in the proper assignment number, and enter your answer for each item.

Your NRCC will be administered by your command or, in the case of small commands, by the Naval Education and Training Program Development Center. No matter who administers your course you can complete it successfully by earning a 3.2 for each assignment. The unit breakdown of the course, if any, is shown later under Naval Reserve Retirement Credit.

WHEN YOUR COURSE IS ADMINISTERED BY LOCAL COMMAND

As soon as you have finished an assignment, submit the completed answer sheet to the officer designated to grade it. The graded answer sheet will not be returned to you.

If you are completing this NRCC to become eligible to take the fleetwide advancement examination, follow a schedule that will enable you to complete all assignments in time. Your schedule should call for the completion of at least one assignment per month.

Although you complete the course successfully, the Naval Education and Training Program Development Center will not issue you a letter of satisfactory completion. Your command will make an entry in your service record, giving you credit for your work.

WHEN YOUR COURSE IS ADMINISTERED BY THE NAVAL EDUCATION AND TRAINING PROGRAM DEVELOPMENT CENTER

After finishing an assignment, go on to the next. Retain each completed answer sheet until you finish all the assignments in a unit (or in the course if it is not divided into units). Using the envelopes provided, mail your completed answer sheets to the Naval Education and Training Program Development Center where they will be graded and the score recorded. Make sure all blanks at the top of each answer sheet are filled in. Unless you furnish all the information required, it will be impossible to give you credit for your work. The graded answer sheets will not be returned.

The Naval Education and Training Program Development Center will issue a letter of satisfactory completion to certify successful completion of the course (or a creditable unit of the course). To receive a course-completion letter, follow the directions given on the course-completion form in the back of this NRCC.

You may keep the textbook and assignments for this course. Return them <u>only</u> in the event you disenroll from the course or otherwise fail to complete the course. Directions for returning the textbook and assignments are given on the book-return form in the back of this NRCC.

PREPARING FOR YOUR ADVANCEMENT EXAMINATION

Your examination for advancement is based on the Occupational Standards for your rating as found in the MANUAL OF NAVY ENLISTED MANPOWER AND PERSONNEL CLASSIFICATIONS AND OCCUPATIONAL STANDARDS (NAVPERS 18068). These Occupational Standards define the minimum tasks required of your rating. The sources of questions in your advancement examination are listed in the BIBLIOGRAPHY FOR ADVANCEMENT STUDY (NAVEDTRA 10052). For your convenience, the Occupational Standards and the sources of questions for your rating are combined in a single pamphlet for the series of examinations for each year. These OCCUPATIONAL STANDARDS AND BIBLIOGRAPHY SHEETS (called Bib Sheets), are available from your ESO. Since your textbook and NRCC are among the sources listed in the bibliography, be sure to study both as you take the course. The qualifications for your rating may have changed since your course and textbook were printed, so refer to the latest edition of the Bib Sheets.

NAVAL RESERVE RETIREMENT CREDIT

The course is evaluated at 8 Naval Reserve retirement points which will be credited upon satisfactory completion of the entire course. These points are creditable to personnel eligible to receive them under current directives governing the retirement of Naval Reserve personnel.

COURSE OBJECTIVE

While completing this nonresident career course, you will demonstrate an understanding of course materials by correctly answering items on the following: Boatswain's Mates billets and duties, rigging, cargo handling, cargo stowage, underway replenishment, anchoring and mooring, towing and salvage, shiphandling, navigation, amphibious duty, painting and damage control organization.

While working on this correspondence course, you may refer freely to the text. You may seek advice and instruction from others on problems arising in the course, but the solutions submitted must be the result of your own work and decisions. You are prohibited from referring to or copying the solutions of others, or giving completed solutions to anyone else taking the same course.

Naval courses may include a variety of questions -- multiple-choice, true-false, matching, etc. The questions are not grouped by type; regardless of type, they are presented in the same general sequence as the textbook material upon which they are based. This presentation is designed to preserve continuity of thought, permitting step-by-step development of ideas. Some courses use many types of questions, others only a few. The student can readily identify the type of each question (and the action required) through inspection of the samples given below.

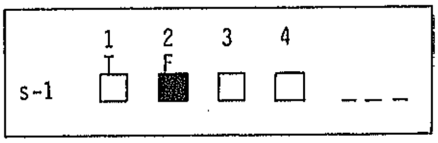
MULTIPLE-CHOICE QUESTIONS

Each question contains several alternatives, one of which provides the best answer to the question. Select the best alternative, and blacken the appropriate box on the answer sheet.

SAMPLE

s-1. The first person to be appointed Secretary of Defense under the National Security Act of 1947 was
1. George Marshall
2. James Forrestal
3. Chester Nimitz
4. William Halsey

Indicate in this way on the answer sheet:



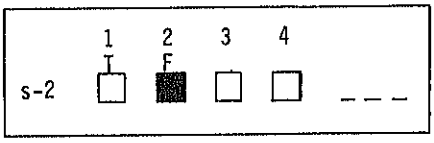
TRUE-FALSE QUESTIONS

Mark each statement true or false as indicated below. If any part of the statement is false the statement is to be considered false. Make the decision, and blacken the appropriate box on the answer sheet.

SAMPLE

s-2. Any naval officer is authorized to correspond officially with any systems command of the Department of the Navy without his commanding officer's endorsement.

Indicate in this way on the answer sheet:



MATCHING QUESTIONS

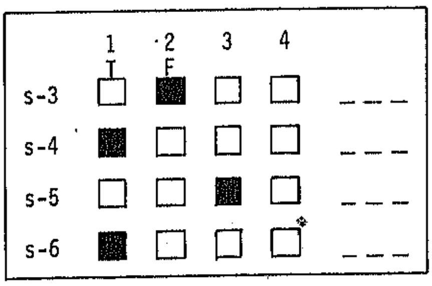
Each set of questions consists of two columns, each listing words, phrases or sentences. The task is to select the item in column B which is the best match for the item in column A that is being considered. Items in column B may be used once, more than once, or not at all. Specific instructions are given with each set of questions. Select the numbers identifying the answers and blacken the appropriate boxes on the answer sheet.

SAMPLE

In questions s-3 through s-6, match the name of the shipboard officer in column A by selecting from column B the name of the department in which the officer functions.

A	B
s-3. Damage Control Assistant	1. Operations Department
s-4. CIC Officer	2. Engineering Department
s-5. Disbursing Officer	3. Supply Department
s-6. Communications Officer	

Indicate in this way on the answer sheet:



Assignment 1

Boatswain's Mate Billets and Duties; Rigging; Cargo Handling

Textbook, NAVEDTRA 10122-E: Pages 1-1 through 3-6

Learning Objective: Recognize duties of division leading petty officer and division chief petty officer.

- Items 1-1 through 1-7 describe situations and problems you might encounter as the leading petty officer of the 1st Division aboard the USS *Iwo Jima*, LPH2.

1-1. You should use the plan of the day in conjunction with your weekly work schedule as a means of

1. making final plans for the week's work
2. altering your daily work schedule to conform with new plans
3. assigning paint details only
4. assigning watch details

1-2. To determine job priorities, you should confer with which of the following officers?

1. Executive officer
2. Operations officer
3. Repair officer
4. Division officer

1-3. As a First Class or Chief Boatswain's Mate you might have responsibility for organizing work crews. Which of the following statements describes a well-organized work crew?

1. The crew knows who is responsible for each job
2. Crew members are proficient in all areas of seamanship
3. The crew's work is accomplished in an efficient manner
4. Each of the above

1-4. You are involved in a dispute with the LPO of another division concerning the responsibility for cleaning a particular area aboard ship. To resolve this matter, which of the following publications should you consult?

1. NWP 14
2. The Ship's Organization and Regulations Manual
3. The Hull Log
4. NAVEDTRA 10122-E

1-5. Which of the following is the most efficient method for you to supervise your division?

1. Delegate authority to your junior petty officer
2. Harp on every small detail
3. Tolerate infractions of division regulations
4. Cover up for your personnel

1-6. You are the leading petty officer of a division. Relating to liberty and leave, which of the following duties are you authorized to perform?

1. Make recommendations on requests for liberty
2. Make recommendations on requests for leave
3. Both 1 and 2 above
4. Grant leave and liberty

1-7. You have the authority to grant or turn down special requests.

Learning Objective: Describe the various logs and records that a Boatswain's Mate First Class or Chief is required to maintain.

1-8. The record that enables you to keep track of personnel changes and assists you in keeping your sections evenly balanced is the

1. inspection checkoff list
2. muster report
3. ship's deck log
4. allowance list

1-9. Which of the following records lists the gear for which your division is responsible?

1. Anchor log
2. Ship's deck log
3. Running inventory
4. Inspection checkoff list

1-10. Which of the following information is recorded in the anchor log?

1. Type of anchor(s)
2. Serial number of anchors
3. Maintenance of ground tackle
4. Each of the above

1-11. Which of the following personnel is required to sign for controlled equipage?

1. Division petty officer
2. Division officer
3. Department head
4. Executive officer

1-12. Personnel who receive controlled equipage may be required to sign which of the following records?

1. Allowance list
2. Memorandum receipt
3. Running inventory
4. Inspection checkoff list

Learning Objective: Describe the forces involved in rigging computations. Solve rigging problems.

● Study Aid: You will need a sharp pencil, a protractor, and a ruler divided into 1/16ths of an inch to help draw diagrams in this section.

1-13. Before using a vector to illustrate a force in a diagram, you must determine the

1. magnitude and direction of the force
2. magnitude of the force only
3. direction of the force only
4. tension represented by the force

1-14. Using the scale 1"=200 pounds, you represent a 500-pound force of gravity by a vector (a) of what length and (b) with the arrow pointing in what direction?

1. (a) of any length (b) arrow pointing up
2. (a) 2-1/2 inches long (b) arrow pointing down
3. (a) 1 inch long (b) arrow pointing down
4. (a) 2-1/2 inches long (b) arrow pointing up

● Information for items 1-15 and 1-16: On a scale of 1 inch=500 pounds, draw vectors representing the forces in a yard-and-stay rig supporting a load of 1500 pounds with the whips 30° on either side of the weight vector.

1-15. The tension in each whip is about how many pounds?

1. 500
2. 875
3. 1500
4. 1750

1-16. The horizontal component of force is about how many pounds?

1. 440
2. 475
3. 500
4. 875

1-17. Which of the following is a result of raising a load on two whips (yard and stay)?

1. The horizontal component of force decreases
2. Tension in the whips decreases
3. The vertical component of force increases
4. Tension in whips increases as the angle between them increases

1-18. Assuming the safe working load (SWL) of each of your cargo whips to be equal to the load being lifted, at what point will tension in a whip equal the SWL?

1. 60° between whips
2. 90° between whips
3. 120° between whips
4. 150° between whips

● Information for items 1-19 and 1-20: A load being racked across the deck is stopped when the angles of the whips from the vertical are 45° for the hatch whip and 60° for the yard whip. The load is 3000 pounds. Select a scale and draw vectors representing the load and the whips.

1-19. Tensions in the whips are about

1. yard whip, 2250 pounds; hatch whip, 3150 pounds
2. yard whip, 2750 pounds; hatch whip, 2250 pounds
3. yard whip, 2250 pounds; hatch whip, 2750 pounds
4. yard whip, 2550 pounds; hatch whip, 2900 pounds

1-20. The horizontal component of force of the hatch whip is approximately how many pounds?

1. 950
2. 1900
3. 2250
4. 2750

1-21. You are about to hoist a load that is slightly greater than the SWL of your rig. What instructions should you give to the winch operator?

1. Keep the load as low as possible and accelerate rapidly
2. Lift the load as high as possible and accelerate rapidly
3. Keep the load as low as possible and accelerate slowly
4. Lift the load as high as possible and accelerate slowly

● To answer items 1-22 through 1-26, you will find it helpful to draw a vector triangle of the forces at work on the different components shown in figure 1A. Information on how to do it can be found under the subheading "Booms, Topping Lifts, and Stays," in Chapter 2 of the textbook.

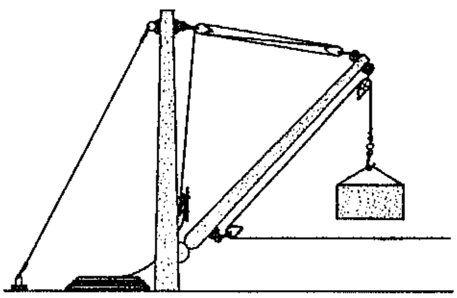


Figure 1A.--Height of mast from boom gooseneck = 20 feet

Length of boom = 24 feet

Angle of boom = 45°

Angle with which stay meets mast = 30°

Weight of load = 3 tons

1-22. Assume the boom shown in figure 1A has a safe working load (SWL) of 4 tons. If a 3-ton load were hoisted, what would the force on the boom be relative to the SWL?

1. Greatly below the SWL
2. Nearly equal to the SWL
3. Equal to the SWL
4. Greatly exceeding the SWL

1-23. In the problem presented in figure 1A, what are (a) the type and (b) the amount of force exerted on the boom?

1. (a) Compression (b) 4-7/8 tons
2. (a) Tension (b) 3-5/8 tons
3. (a) Compression (b) 3-5/8 tons
4. (a) Tension (b) 4-7/8 tons

1-24. What component shown in figure 1A has the greatest force exerted upon it?

1. Boom
2. Topping lift
3. Mast
4. Stay

1-25. In figure 1A, what is the approximate amount of compression on the mast?

1. 2-5/8 tons
2. 3-5/8 tons
3. 4-7/8 tons
4. 5-1/8 tons

1-26. You are operating the boom shown in figure 1A with 3-ton loads. You know that the stay will stand a tension of 4 tons. To operate the boom safely, what action must you take?

1. Rig a stronger topping on the stay
2. Rig a gun tackle purchase on the stay
3. Increase the whip strength by at least 2.6 tons
4. Add another stay with a capacity of at least 1.25 tons

1-27. When erecting a gun pole, you should anchor the guys at a distance from the shoe of the pole that will cause the length of the guys to be equal to at least

1. the length of the pole
2. one and one-half times the length of the pole
3. twice the length of the pole
4. twice the length of the pole for the after guy and one and one-half times the length for the side guys

1-28. When you are rigging guys for use with a gin pole, which of the following is a rule you should follow?

1. Never use more than three guys
2. Space the guys at an angle of 60° from each other
3. Rig a forward guy when there is a chance that the load is to be moved past the vertical position
4. Hoist the load when the side guys are taut and the after guy is slack

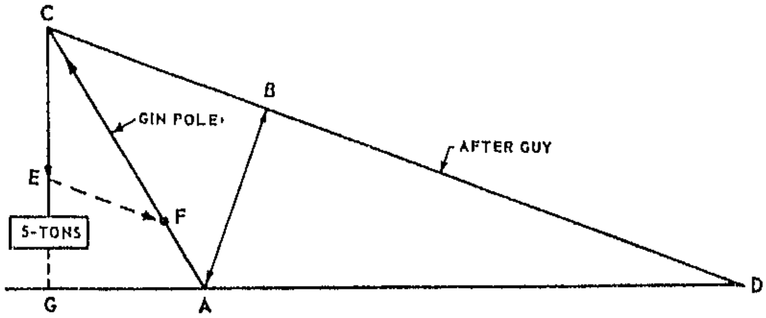


Figure 1B.

● Information for items 1-29 through 1-33: Figure 1B above shows a vector diagram of a gin pole that is resting on a 1 square-foot shoe. The gin pole is 10 feet long and 8 inches in diameter. In the force triangle CEF, CE is shown as 1 inch to make the scale of 1 inch=5 tons. This makes EF=13/16 inch and FC=1-1/2 inches.

1-29. What is the minimum permissible length of the after guy shown in figure 1B?

1. 5 feet
2. 10 feet
3. 20 feet
4. 40 feet

1-30. What was the tension on the after guy with the gin pole set up as it was originally in figure 1B?

1. 1-1/2 tons
2. 2 tons
3. 5 tons
4. 4 tons

1-31. In figure 1B, what point represents the structure joint of the rig?

1. A
2. B
3. C
4. F

1-32. Assume you have to slack off the after guy in figure 1B until the horizontal distance (GA) between the weight and the shoe of the gin pole is increased to 8 feet. This causes the distance (AB) between the shoe of the gin pole and the after guy to decrease to 4 feet. After you have made this change, how does the tension on the after guy compare with the weight of the load?

1. The tension of the guy is half the weight of the load
2. The tension of the guy is equal to the weight of the load
3. The tension of the guy is twice the weight of the load
4. The tension of the guy is four times the weight of the load

1-33. In figure 1B, what is the compression in the gin pole?

1. 5 tons
2. 7.5 tons
3. 8 tons
4. 10 tons

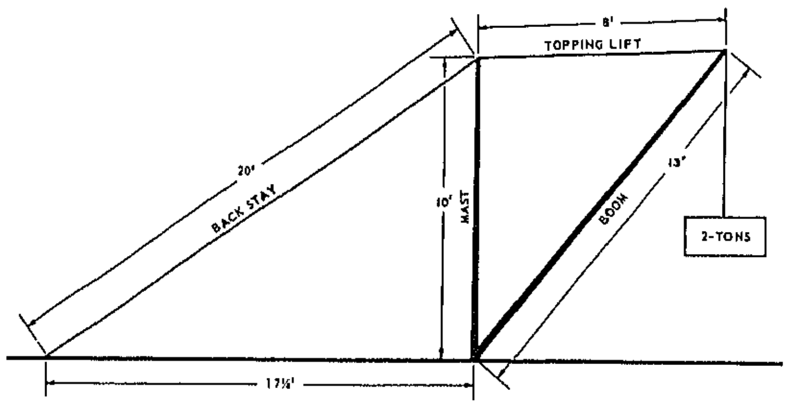


Figure 1C.--Swinging derrick.

1-34. Assume you are erecting a swinging derrick using the ship's mast. After making your force calculations, you find that the deck below the mast will not stand the combined force of the mast and boom compression. You can solve this problem by

1. stepping the boom a distance up the mast from the deck
2. using a boom that will withstand greater compression
3. lowering the boom to change the force on it
4. stepping the boom away from the mast

1-35. It is possible to erect a jury mast without cutting a hole in the deck by using

1. two after guys
2. shoring
3. a separate shoe for the gin pole
4. an open hatch

1-36. To rig the swinging derrick shown in figure 1C above, you need a topping lift that can withstand a tension of

1. 1.6 tons
2. 2 tons
3. 8 tons
4. 4.5 tons

1-37. Upon examination of the backstay shown in figure 1C you find that it is frayed near the deck anchoring point. You cut 5 feet off the backstay to eliminate the frayed part and anchor it to the deck at a point approximately 6-1/4 feet nearer the mast. Tension on the backstay is now about equal to the

1. weight of the load
2. compression of the mast
3. compression of the boom
4. tension on the topping lift

1-38. To gain maximum use from two 12-foot shears, what basic rules should you keep in mind when you rig and set them up?

1. Lash the poles together with some slack and space the legs about 6 feet apart
2. Lash the poles together with some slack and space the legs about 4 feet apart
3. Lash the poles together as tightly as possible and space the legs about 4 feet apart
4. Lash the poles together as tightly as possible and space the legs about 6 feet apart

● Information for items 1-39 through 1-42: Assume that figure 1D is a parallelogram of forces diagram for computing the forces acting on the legs of a shear leg rig.

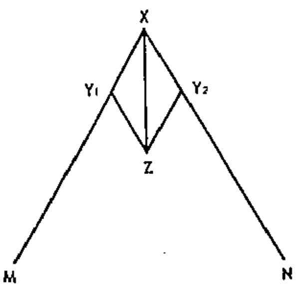


Figure 1D

1-39. What does line XZ in figure 1D represent?

1. Weight of the load
2. Force acting on one shear leg
3. Tension on the back guy
4. Force acting on both shear legs

1-40. The angle MXN shown in figure 1D represents the angle formed by the

1. back guy and the shear legs
2. whip and the shear legs
3. shear legs
4. whip and the back guy

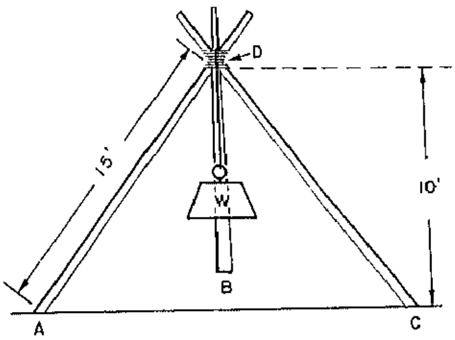
● Information for items 1-41 and 1-42: Assume that figure 1D is a parallelogram of forces diagram for computing the forces acting on the back guys of a shear leg hoist.

1-41. Line XZ shown in figure LD represents the

1. weight of the load
2. tension on one back guy
3. distance between the back guy anchoring points
4. combined tension in the back guys

1-42. Line XY2 shown in figure 1D represents the

1. weight of the load
2. tension on one back guy
3. resultant compression of one shear leg
4. tension on the tackle between the shear legs



Length of legs below lashing = 15 feet
Height of lashing above deck = 10 feet
Weight = 800 pounds
Drift = 11 feet

Figure 1E.--Tripod rig.

● Information for items 1-43 and 1-44: You point out three spars to BM3 John Martin and you tell him to rig a tripod to handle a weight of 800 pounds. Later, Martin asks you to check the rig. The rig is like that pictured in figure 1E.

1-43. What rule has Martin violated?

1. A tripod rig with 15-foot legs cannot exceed 9 feet in height
2. Distance between legs should be not less than 1/2 nor more than 2/3 the length of a leg
3. Distance between legs should not exceed 1/4 the length of a leg
4. A tripod rig cannot be used for a weight exceeding 750 pounds

1-44. Leaving the top lashing in place, you shorten the distance between legs until drift (distance between the plum line of action of the weight and a leg) is 7 feet. Now the thrust on a single leg is approximately how many pounds?

1. 600
2. 200
3. 300
4. 900

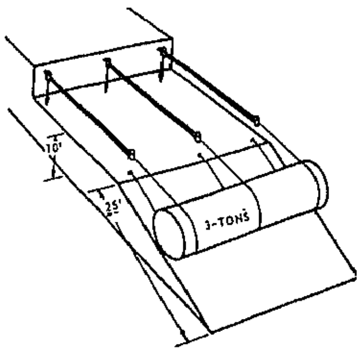


Figure 1F

1-45. Assume that you are using a parbuckling rig consisting of three runners to raise the weight shown in figure 1F. You have clapped a twofold tackle on each runner. In addition to the pull exerted to overcome friction, what pull must the person on each runner exert to raise the weight?

1. 67 pounds
2. 100 pounds
3. 200 pounds
4. 400 pounds

1-46. In parbuckling, a runner has a mechanical advantage of

1. 6
2. 2
3. 3
4. 4

1-47. To make a turn using rollers to move a heavy weight, the front rollers must be inclined in the direction of the turn and the rear rollers in the opposite direction.

1-48. When making a jury rig, you should select a timber whose grain lies

1. at a right angle to the length of the timber
2. along the length of the timber
3. parallel to the direction of thrust
4. at a right angle to the direction of thrust

1-49. You have to make a jury rig to lift a piece of equipment weighing 5 tons onto a cradle. There are three oak spars available, each 20 feet long. One has a diameter of 8 inches, one 9 inches, and the other 10 inches. Disregarding friction and force angles, will any of the spars hold the 5-ton weight? If so, what is the minimum diameter required?

1. No
2. Yes, 8 inches
3. Yes, 9 inches
4. Yes, 10 inches

1-50. If you want to prevent cant as you reeve a threefold tackle, what principle should you keep in mind?

1. Keep the becket and the hauling part on opposite sides of the tackle
2. Keep the becket and the hauling part separated by at least one sheave
3. Reeve the hauling part through the middle sheave
4. Reeve the hauling part through either end sheave

1-51. If the lower block is fitted with a swivel, which of the following tackle patterns is suitable for boat falls?

1. Right-angle threefold
2. Parallel threefold
3. Right-angle double luff
4. Each of the above

1-52. Which of the following tackle patterns is best suited as a jumbo boom topping lift?

1. Any right-angle fourfold
2. Only a fourfold reeved in the manner taught at diver's school
3. A parallel threefold
4. A parallel fivefold

1-53. What is the mechanical advantage, if any, of two gun tackle purchases rigged as a Spanish burton?

1. Eight
2. Two
3. Four
4. None

1-54. What is the length of a stay running from the top of an 85-foot mast to a deadman located 40 feet from the base of the mast?

1. 88 feet
2. 90 feet
3. 94 feet
4. 99 feet

1-55. When preparing to make a short splice in wire rope, what must you do before unlaying the rope?

1. Place the rope in the rigger's screw
2. Place temporary seizings on the ropes
3. Whip the strands
4. Marry the ends

1-56. In the short splice, the temporary seizings should be approximately how many times the diameter of the rope from the end of the rope?

1. 12
2. 24
3. 36
4. 48

1-57. You have been told to make a long splice in a 1/2-inch diameter wire. Which of the following lengths of wire should you use for this splice?

1. 10-foot
2. 20-foot
3. 30-foot
4. 40-foot

1-58. The purpose of the Spanish windlas used in making a long splice in wire rope is to open the lay of the rope.

Learning Objective: Identify types of cargo loading. Describe cargo loading plans.

For items 1-59 through 1-64: From column B, select the term that best fits the definition or description in column A.

	A. Definition/ Descriptions	B. Terms
1-59.	Cargo for different ports isolated where it can be off-loaded without disturbing other cargo	1. Combat loading
1-60.	Primary consideration is facility for landing troops, equipment, and supplies	2. Commodity loading
1-61.	Cargo isolated by type	3. Administrative loading
1-62.	Maximum use made of space	4. Selective loading
1-63.	Used only for non-tactical loading	
1-64.	Type of loading used most frequently on replenishment ships	

1-65. Part of a battalion and its equipment and supplies are loaded into one ship and the rest are loaded into another ship. The method of loading used is combat

1. organizational loading
2. spread loading
3. tactical loading
4. unit loading

1-66. To determine the cubic content of a ship's cargo space, you should consult what ship's document?

1. Loading characteristics pamplet
2. Loading plan
3. Profile loading diagram
4. Unit storage diagram

1-67. Responsibility for preparing the combat loading plan belongs to the

1. embarkation officer
2. combat cargo officer
3. embarkation team commander
4. ship's commanding officer

1-68. The numeral preceding each item of cargo shown on the profile loading diagram indicates the

1. priority of unloading
2. number of items of that type
3. number of people required to unload the item
4. number of lifts required to unload the item

1-69. Which of the following is a duty of the embarkation team advance party?

1. To provide lighterage for loading
2. To provide police details
3. To provide winchmen
4. To provide riggers

1-70. Ensuring a landing craft is at its assigned unloading station at the proper time is a responsibility of the

1. ship's debarkation officer
2. troop debarkation officer
3. first lieutenant
4. hatch officer

1-71. What is the type of unloading that normally begins after consolidation by troops ashore, and is designed to deliver the maximum amount of supplies in the shortest time?

1. General
2. Initial
3. Selective
4. Emergency

Assignment 2

Cargo Handling (continued); Cargo Stowage; Underway Replenishment; Anchoring and Mooring

Textbook, NAVEDTRA 10122-E: Pages 3-6 through 6-11

Learning Objective: Recognize the duties and responsibilities of a hatch captain and hatch crew.

2-1. Ensuring booms are properly rigged for unloading cargo is the responsibility of what person?

1. Winchman
2. Hatch captain
3. Hatch tender
4. Cargo officer

2-2. Assume you are discharging cargo by the yard-and-stay transfer method without the use of steadying lines. Which of the following is the best method for stopping loaded pallets from swinging dangerously?

1. Transfer the load rapidly from the hatch boom winch to the yard boom winch
2. Load the maximum possible amount of cargo on the pallet
3. Take up the load with the yard boom winch when the pallet is at the top of its outboard swing
4. Slack off the hatch boom winch when the pallet is at the top of its outboard swing

2-3. When you use the yard-and-stay transfer method, the load is supported by both winches only when

1. lowering
2. stacking
3. racking
4. hoisting

2-4. To determine whether a load will exceed the capacity of the winch being used is whose responsibility?

1. Winchman
2. Hatch tender
3. Safety observer
4. Hatch captain

2-5. To determine the weight of heavy equipment such as trucks, the hatch captain should consult which of the following references?

1. Stowage diagram
2. Embarkation plan
3. Loading plan
4. COSAL

2-6. All mechanical hatch covers are watertight.

2-7. When must wire ropes used in cargo handling be inspected?

1. Before operations
2. During operations
3. After operations
4. Each of the above

2-8. The part of the cargo boom that requires special attention is the

1. boom head
2. heel of the boom
3. gooseneck
4. boom shaft

2-9. The topping lift of a cargo boom should be long enough to

1. permit the boom to be cradled
2. permit the hauling part to be shifted to another winch
3. lower the boom head to the deck
4. spot the boom head over the pier

Learning Objective: Describe methods of cargo stowage. Identify equipment used in cargo stowage.

2-10. Which of the following cargo stowage objectives is sacrificed to gain the advantage that combat loading provides?

1. Speed in unloading
2. Protection of the crew from injury
3. Protection of the cargo from damage
4. Maximum use of space available

To answer questions 2-11 through 2-13, select from column B the term that best fits each of the descriptions in column A. Not all responses are to be used.

	A. Descriptions	B. Terms
2-11.	Cargo is stowed in layers over the entire hold	1. Vertical stowage
2-12.	Classes of cargo are stowed separately but are accessible from the square of the hatch	2. Horizontal stowage
2-13.	Various kinds of equipment or supplies are stowed together	3. Block stowage
		4. Combat stowage

2-14. Which of the following statements concerning cargo holds is true?

1. The hold must be clean and dry
2. Drains must be operative
3. Ladders must be inspected and repaired
4. Each of the above

2-15. When stowing boxes, which of the following precautions must you observe?

1. Work from both sides toward center
2. Work from forward to aft
3. Keep each tier level
4. Separate each tier by a floor of dunnage

2-16. In what manner must you stow cardboard cartons?

1. One on top the other
2. Brick fashion
3. Endwise
4. Lengthwise

2-17. When stowing crates, you must place dunnage between every tier of crates.

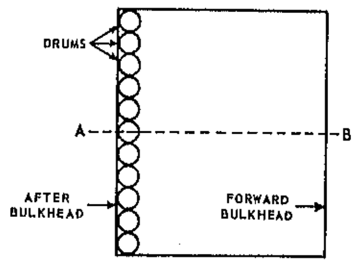


Figure 2A.--Top view of a cargo load.

2-18. If the drums in place in figure 2A are not snug against the sides of the ship, how many drums will you need to make up the next row?

1. 12
2. 11
3. 10
4. 9

2-19. Which of the following is the primary purpose of the venetian vent?

1. To prevent bending of chines
2. To prevent circulation of air
3. To hold irregular-size cargo
4. To promote circulation of air

2-20. When you are placing venetian vents, what is the minimum distance required between vents?

1. 5 feet
2. 2 feet
3. 3 feet
4. 4 feet

2-21. What is the recommended minimum number of gripes for lashing wheeled and tracked cargo?

1. One
2. Two
3. Three
4. Four

2-22. Vehicle lashing sockets are used on amphibious vessels to secure vehicles on deck because their use eliminates the need for

1. chock braces
2. chocks
3. dunnage
4. gripes

2-23. Listed below are precautions normally taken in stowing vehicles below decks. When the vehicles are to participate in an invasion, which of the following precautions do you NOT observe?

1. Griping down each vehicle
2. Placing dunnage under gripes
3. Chocking all wheels
4. Draining fuel tanks

2-24. Regardless of the safe deckload height of a cargo ship, cargo should NEVER be stowed above how many feet when stowage requires more than one tier?

1. 12
2. 14
3. 16
4. 18

2-25. The width of a catwalk should NOT be less than how many feet?

1. 5
2. 6
3. 3
4. 4

2-26. How many round turns should be taken on a deck load consisting of a wooden case 30 feet long?

1. One
2. Two
3. Three
4. Four

2-27. While taking a turn about the deck, BM1 Joe Smith notices that the 1/2-inch wire lashing securing a block of deck cargo has some slack in it. When he tries to make the lashing taut again he finds there isn't enough space left for taking up on the turnbuckle. Consequently he must shorten the lashing. How many wire clips should he use, and how far apart should he space them to secure the lashing to the turnbuckle again?

1. 3 clips, 6 inches apart
2. 2 clips, 2 inches apart
3. 3 clips, 3 inches apart
4. 3 clips, 4 inches apart

2-28. When tanks are stowed on the deck, they are chocked with timbers on all four sides. How high should the upper surfaces of (a) the sides and (b) the ends of these timbers be from the deck?

1. (a) 8 inches (b) 8 inches
2. (a) 8 inches (b) 12 inches
3. (a) 12 inches (b) 8 inches
4. (a) 12 inches (b) 12 inches

2-29. Aboard ship, flammable liquids may be stowed in which of the following spaces?

1. Between decks
2. On deck
3. Either 1 or 2 above, depending upon the type of container

2-30. To stow flammable liquids safely on deck, which of the following precautions should you observe?

1. Place containers at least 25 feet from fireplugs
2. Rig a foam proportioner
3. Lay out a charged firehose
4. All the above

Information for item 2-31: While loading cargo, you enter number 2 hold and find 25 bottles of oxyacetylene gas stowed in the following manner:

A. Flat on the bare deck
B. Thirty feet from a class A explosive
C. Under a bottle of acid

2-31. You become alarmed because which of the following condition(s) exist(s)?

1. B violates a safety precaution
2. C violates a safety precaution
3. A is contrary to common sense
4. Each of the above

To answer questions 2-32 through 2-36, select from column B the class of explosives for each explosive listed in column A. Classes may be used more than once.

	A. Explosives	B. Classes of Explosives
2-32.	Smoke pots	1. Class A
2-33.	Smokeless powder	2. Class B
2-34.	Marine illumination signal	3. Class C
		4. Blank
2-35.	Commercial dynamite	
2-36.	Time fuzes	

2-37. In the metal dunnage system, how is cargo tommed down?

1. By wedging shores against the overhead
2. With ratchet tensioning devices
3. With penboards
4. With cotton web straps

2-38. The handling and stowage of dangerous cargo aboard ship are governed by which of the following reference sources?

1. Ship's loading plan
2. Ship's blueprints
3. COSAL
4. Code of Federal Regulations, Title 46

Information for item 2-39: Your ship is moored portside to a pier. At the starboard side is an ammunition lighter. While inspecting preparations for handling ammunition, you see that arrangements at #2 hatch are as follows:

A. A yard-and-stay rig to work the lighter

B. A burton rig to work the pier. The inboard burton whip is rove through a block at the head of the hatch boom of the yard-and-stay rig

C. Equipment assembled for use includes skip boxes, handtrucks, an electric-powered (approved) forklift truck in the hold, cargo nets with pallets as bases, and several slings and bridles in good shape

2-39. You notify the first lieutenant that arrangements at #2 hatch are unsatisfactory because

1. you cannot use a burton rig to handle ammunition
2. the combination of A and B violates safety precautions
3. the equipment listed in C contains an unauthorized item
4. you cannot work a lighter with a yard-and-stay rig

● Information for items 2-40 through 2-42: You are loading cargo, much of which are class A and B explosives. All of this ammunition is being stowed in #1 hold which is sprinkler-protected. You notice a boxed carboy (bottle) stenciled with the hazard identification symbol shown in figure 2B.

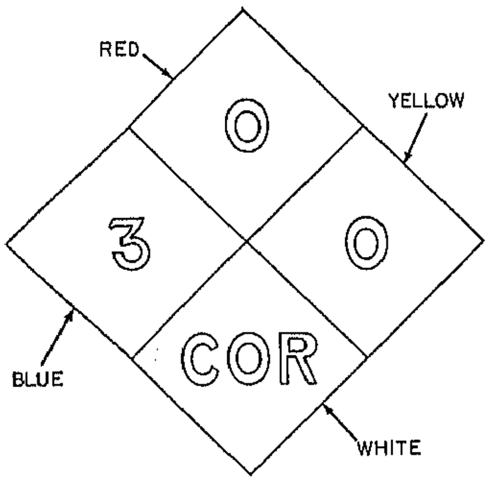


Figure 2B.--Hazard identification symbol.

2-40. From the symbol, you deduce that the contents of the box are

1. harmless
2. highly dangerous corrosive
3. a mildly irritating alkali
4. a mildly irritating corrosive

2-41. The supply officer comes up and tells you to stow the box in a hold containing supplies for ship's stores. Which of the following actions should you take?

1. Comply, because there are no instructions to the contrary
2. Protest, because the contents may be harmful to food and tobacco
3. Protest, because the contents belong in a sprinkler-protected hold
4. Comply, because a supply officer should know requirements for dangerous cargo

2-42. A BM3 suggests that you put the box in #1 hold. The gunner says that you can't put it in #1 hold and to put it in #4 hold which contains lumber and other building material. Which of the following statements is correct?

1. The BM3 is wrong, because the contents of the box must be kept from water
2. The gunner is wrong, because if the contents of the box should spill, they will ruin the lumber
3. The suggestion of the BM3 is good, because the box should be in a sprinkler-protected hold
4. The gunner is right, because material such as that in the box cannot be stowed below decks with class A or class B explosives unless a hold or the machinery spaces separate the two

2-43. Occasionally, Department of Transportation hazardous labels appear on shipping containers. A number 2 at the bottom of a label without any name identifies the material in the container as a(n)

1. explosive
2. oxidizer
3. gas
4. poison

Learning Objective: Describe the responsibilities of a supervisor on an underway replenishment station.

2-44. To ensure that an underway replenishment team is properly trained, you should never shift personnel from one task to another.

2-45. As the supervisor of an UNREP station, which of the following actions should you take prior to an evolution?

1. Review safety precautions with your crew
2. Question personnel breaking in on new positions
3. Tell your petty officers to evaluate the evolution
4. Each of the above

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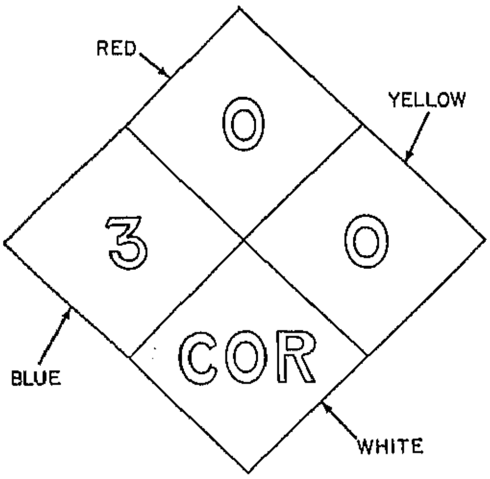

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2-46. The best way to train a petty officer as supervisor of an UNREP station is to use which of the following tactics?

1. Let the PO take charge of part of the operation
2. Let the PO take charge of the station while you stand by to observe and assist
3. Let the PO stand back and observe
4. Let the PO follow you around

2-47. During a post-UNREP critique, it is reported that a seaman deliberately violated a safety precaution. What action should you take?

1. Tell the rig captain to re-instruct the seaman
2. Give the matter your personal attention
3. Let the division officer take care of the seaman
4. Forget it, since it probably won't happen again

2-48. The first lieutenant has asked for your recommendation on whether to use an old UNREP method or a new method that requires new equipment you have received. What should you recommend?

1. That somebody be brought aboard to train personnel before changing to the new method
2. That all the BMs vote on the matter
3. That you use the new method because, once learned, it probably will be more efficient and safer
4. That you continue to use the old method because your personnel are familiar with it and, therefore, it is safer

2-49. To ensure that your station is equipped and ready for UNREP, you should consult which of the following references?

1. ATP 16
2. Station checkoff list
3. Ship's organization and regulations manual
4. Equipment guide list

2-50. The purpose of a supplemental checkoff list is to ensure that you have the proper equipment for night replenishment.

Learning Objective: Describe procedures and methods for anchoring and for making a Mediterranean moor, a foul weather moor, and a buoy moor. Recognize the duties of a BM1 or BMC while anchoring, making a Mediterranean moor, foul weather moor and a buoy moor.

2-51. Why should a ship be moving when the anchor is dropped?

1. To set the anchor and keep the chain from piling on it
2. To hit the exact center of the berth more easily
3. To avoid damaging the stem, sonar dome, or other part of the ship

2-52. When using the stopper release method for letting go an anchor, which of the following stoppers do you NOT remove from the chain prior to letting go?

1. Riding stopper
2. After stopper
3. Housing stopper
4. All the above

2-53. The purpose of an anchoring nomograph is to determine the minimum scope of chain to use.

2-54. After the ship is anchored, one of your crew asks you what special care must be taken when anchoring in deep water. What do you reply?

1. The approach must be extra slow, and the anchor must be walked to within 5 to 20 fathoms of the bottom
2. The ship must always be backing when the anchor is dropped
3. When the water is over 35 fathoms deep, the anchor should be walked all the way to the bottom
4. All the above

2-55. The special sea and anchor detail is set the next day for getting underway. The OOD orders "Heave around to short stay" and after heaving in a few fathoms you notice the chain is tending 9 o'clock and has a heavy strain. What action should you take?

1. Drop the anchor and then heave in again
2. Veer the chain quickly and then brake it to a sudden stop to clear it
3. Continue heaving in and request the OOD to twist the ship to starboard
4. Avast heaving and report the tend of chain and the amount of strain on the cable to the OOD

2-56. The anchor is aweigh, and after heaving around for a few minutes the windlass suddenly takes a strain. You order "avast heaving," suspecting that the most logical reason for the strain is that the anchor is

1. housed
2. breaking ground
3. foul on the forefoot
4. foul in its own cable

2-57. You are on a ship with a bow mounted sonar and are to use the bower anchor for anchoring. You can expect that before giving the order to drop the anchor, the conning officer will take which of the following actions?

1. Bring the ship to a stop
2. Have the ship backing
3. Either 1 or 2 above, depending on the situation at the time
4. Have the ship forging ahead

2-58. Which of the following is probably the main reason port authorities require the use of the Mediterranean moor?

1. It enables a ship to get underway quickly in an emergency
2. It allows easy access to the shore by the use of the stern brow
3. It provides a safe moor in case of heavy weather
4. It allows many ships to moor in crowded areas

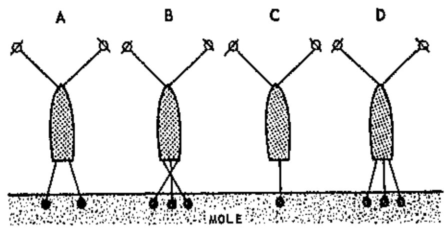

Figure 2C

2-59. Which diagram in figure 2C shows the most secure final position of a ship using a Mediterranean moor?

1. A
2. B
3. C
4. D

2-60. For you to obtain maximum security in a Mediterranean moor, each anchor chain should tend how many degrees from the bow?

1. 20
2. 45
3. 60
4. 90

2-61. The primary purpose of a chain compressor is to provide an auxiliary means of controlling and securing an anchor chain.

● Information for items 2-62 and 2-63: Because of an approaching storm, your destroyer is making a foul weather moor 2,500 yards from a beach in the Mediterranean. The wind is from the southeast but is expected to shift into the southwest as the storm passes.

2-62. Which of the following preparations should you make for anchoring?

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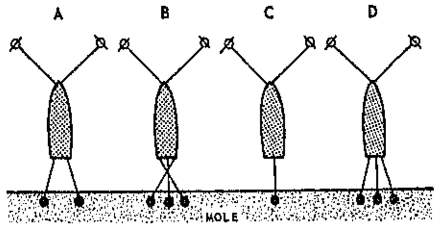

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2. Prepare to use the port anchor as the riding anchor
3. Prepare to use the port anchor as the underfoot anchor
4. Each of the above

2-63. When the riding anchor is dropped, you veer to 70 fathoms, secure the stoppers, and shift the second anchor to the wildcat. The first lieutenant informs you that 20 fathoms of chain will be veered to the underfoot anchor. At what point should the underfoot anchor be let go?

1. At the end of the ship's yaw to port
2. At the end of the ship's yaw to starboard
3. At a point underfoot parallel to the wind and the riding anchor
4. When the ship is in a position with the wind off its starboard bow

2-64. The use of a dip rope is necessary when using the trolley method of mooring to a buoy.

2-65. When you instruct your crew on mooring to buoys by the bow and stern method, how should you describe the sequence of actions?

1. After wire rope is secured to the after buoy, the ship will be maneuvered so that chain can be passed to the forward buoy
2. After wire rope is secured to the forward buoy, the ship will be maneuvered so that chain can be passed to the after buoy
3. Chain will be secured to the forward buoy and wire rope to the after buoy simultaneously, then the distances will be equalized
4. After chain is secured to the forward buoy, wire rope will be passed to the after buoy; then the ship will maneuver between the buoys

2-66. How often should anchor cable up to and including 1-1/2 inch be ranged on deck and examined by the ship's force?

1. Every 3 months
2. During every yard overhaul period
3. Twice a year
4. Once a year

2-67. Detachable link parts are interchangeable.

2-68. The mixture used to slush detachable links is

1. white lead and graphite
2. white lead and petrolatum
3. tallow and white lead
4. tallow and graphite

2-69. How often must all anchor chain be examined and overhauled?

1. Twice a year
2. Once a year
3. Every 1-1/2 years
4. Every 2 years

2-70. What is the official breaking strength of the shackle used to secure the bitter end of an anchor chain to a pad eye in the chain locker?

1. The weight of 300 fathoms of the chain
2. Three-fourth's the breaking strain of the weakest link
3. One and three-fourth's times the weight of the chain
4. Slightly less than the breaking strength of the chain

2-71. The breaking strength of the pad eye in the chain locker must be at least how many times the breaking strength of the shackle?

1. 2-1/4
2. 2
3. 1-3/4

Assignment 3

Towing and Salvage; Shiphandling; Navigation

Textbook, NAVEDTRA 10122-E: Pages 7-1 through 9-3

Learning Objective: Recognize equipment used in towing and describe towing procedures.

3-1. Aboard your ship, which of the following is the best procedure to use for towing?

1. NAVEDTRA 10122-E
2. Ship's rigging plan for towing and being towed
3. Naval Ships' Technical Manual, chapter 9250
4. Salvor's Handbook

3-2. Alongside towing is generally confined to seagoing tows.

3-3. The electric automatic towing machine has stowage for a maximum of 300 fathoms of 2-inch wire rope.

3-4. In an emergency, the entire towing hawser may be released by disconnecting which of the following controls?

1. Rotary drum switch
2. Reclaiming motor
3. Magnetic brake
4. Clutch brake

3-5. Which of the following conditions determines the approach to a disabled vessel?

1. Size of the towing vessel
2. Relative drift
3. Maneuvering characteristics of the towing vessel
4. Each of the above

● Information for questions 3-6 through 3-11: Assume that you are a BMC commanding the USS *Lucemo*, an ATF out of Newport, R.I. It is the month of March and the area is having a late winter storm with heavy seas and high winds.

The ship is moored at Goat Island when a call comes through for you to get under way and proceed to the area just east of Nantucket Island on a towing mission.

You are informed that the Nantucket Lightship has broken its moorings and is drifting toward the beaches of Cape Cod. Your job is to take the lightship in tow to keep it from going aground until the wind and seas abate. Then you are to tow it first to Falmouth and then through the Cape Cod Canal to Boston for repairs.

While en route to the scene, you plan a course of action. The lightship probably has steam up for its anchor windlass, but of course has no engines for propulsion. You also know that it has very little draft and a high top-side sail area.

You figure that the lightship's drift rate and length of time adrift should bring it to a point about 15 miles northeast of Nantucket Island by the time you can reach that area. When you sight the lightship, it is sailing broadside to the wind, as expected, drifting northwest and heading west.

3-6. First you check the relative drift and find that your vessel has the slower drift rate. To pass the towline, what is the best position for you to take relative to the lightship?

1. Close aboard off the port beam
2. Slightly ahead and to port
3. Slightly ahead and to starboard
4. Close aboard off the starboard quarter

3-7. Which of the following approaches would be most logical for you in your ATF? Why?

1. Parallel approach, because the tow drifts faster
2. Crossing the T approach, because the lightship's heading is 90° from her direction of drift
3. 45° approach from the tow's port side, because then you will be heading into the wind
4. Backdown approach, because this is the usual approach for an ATF and circumstances do not necessarily call for a change

3-8. With the aid of a line-throwing gun, the messenger is passed and the lightship crew begins to heave around. You plan to have the lightship crew secure the hawser to their anchor chain and then veer the chain to about 30 fathoms. Which of the following reasons for this plan of action is most important?

1. The chain is heavier than the hawser and the weight improves the catenary
2. The chain provides a longer towline than the hawser alone
3. The chain eliminates chafing at the bullnose
4. The chain is easy to let go quickly if necessary

● Information for items 3-9 and 3-10: After managing a 90° turn into the wind with the tow, you adjust the towing hawser to 280 fathoms which keeps the ships in step and provides a good catenary. While maintaining just enough headway to prevent drifting closer to shore, you notice an occasional very heavy strain on the hawser and erratic movement of the tow.

3-9. A glance at the chart tells you that you are in shallow water and this means that the towline is probably dragging on the bottom. What signal to the tow do you make on your whistle?

1. One short blast
2. Two short, one prolonged blast
3. One prolonged, two short blasts
4. One short, two prolonged blasts

3-10. After the storm has abated you come to a westerly course at a speed of 6 knots. En route to Falmouth it becomes increasingly difficult for the ships to remain in step. What procedure should you use to gain better control of the tow and reduce the excessive strain on the towline?

1. Reduce speed
2. Shorten the towline
3. Increase speed
4. Veer the towline

● Information for item 3-11: When you are 2 miles off Falmouth Harbor entrance, you prepare to take the tow alongside for greater maneuverability.

3-11. Since the channel will be curving slowly to the left when you enter, what is the proper position for you to take alongside the tow?

1. On its starboard bow
2. On its port bow
3. On its starboard quarter
4. On its port quarter

3-12. For multiple tows (several barges) at sea, which of the following methods is preferred?

1. Honolulu rig
2. Christmas tree rig
3. Secure the barges alongside
4. Push the barges

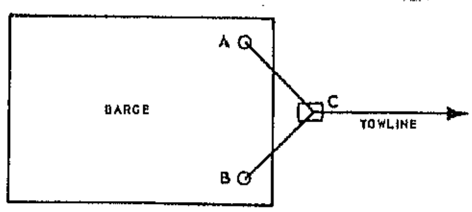

Figure 3A

3-13. If the distance between points A and B in figure 3A is 7 feet, what must be the minimum length of legs AC and BC to have a safe towing rig?

1. 14 feet
2. 7 feet
3. 5 feet
4. 4 feet

must be the length of leg
ı figure 3A for it to take
the strain of the hawser?

.4 feet
7 feet
5 feet
4 feet

ıing Objective: Recognize
:ipal types of salvage and
cibe salvage procedures.

---

s 3-15 through 3-19, select
B the type of salvage
n column A. Responses may
e than once.

escriptions	B. Types of Salvage
ving sunken from nel	1. Rescue salvage
age services n amphibious ult force	2. Harbor salvage
oating ıels in ›sed ıtions along ›ast	3. Offshore salvage
:gency salvage ʼices to ships ıircraft in :ress at sea	4. Combat salvage
ing ships to afe harbor	

---

main cause of damage to ships
a harbor is collision.

ormation for questions 3-21
ough 3-25: Assume you are in
an inshore tug. The
has run aground on a sandbar
ea. You answer *Vulcan's*
all and are first on the scene.

3-21. *Vulcan* has stranded at right angles to the beach, bow on, with stern afloat. This lessens the danger of *Vulcan's*

1. breaking its back
2. washing higher on the beach
3. pounding
4. broaching

3-22. When your tug reaches *Vulcan*, which of the following actions should you take first?

1. Determine the exact position of *Vulcan* on the sandbar
2. Attempt to tow *Vulcan* off the sandbar
3. Determine whether proper steps have been taken to reduce the effects of waves and currents
4. Sound the entire grounding area

3-23. Which of the following hazards will your tug face in rescuing *Vulcan*?

1. Parting the towline
2. Running aground
3. Colliding with *Vulcan* when it clears the beach
4. Damaging ground tackle machinery

● Information for items 3-24 through 3-25: When you reach *Vulcan*, the ship's anchors are already laid out to seaward and are firmly embedded on the bottom. You and the *Vulcan's* captain decide that wrenching will be more effective than a straight pull.

3-24. You begin by rigging a Liverpool bridle. In this rig, how is the strain of the tow taken?

1. Equally by lazy jacks and pendants
2. By the line between the carpenter stopper and the winch
3. By the pendant alone
4. Equally by lazy jacks and winch

3-25. Your first wrenching pull is to port of the *Vulcan*. Which of the following actions should the captain take?

1. Take a strain on the starboard anchor chain only
2. Take strain on the starboard anchor chain and walk out the port chain
3. Walk out the starboard anchor chain
4. Walk out the starboard anchor chain and take a strain on the port chain

---

Learning Objective: Describe methods of carrying out an anchor by small craft.

3-26. A single boat may carry out an anchor when

1. the capacity of the boat is greater than the weight of the anchor
2. bad weather makes operations dangerous to equipment and personnel
3. the stranded vessel is aground in water too shallow to permit a tug to come alongside
4. additional boats are unavailable

3-27. When carrying an anchor out over the stern of a boat, you should secure the pelican hook with a preventer to prevent

1. loss of the strap
2. injury to crewmembers
3. damage to the boat
4. loss of time in letting go

3-28. The safest way to carry out an anchor whose weight is near the working load of a boat is to hang the anchor where?

1. Between two boats
2. On a belly strap under the boat's keel
3. Off the boat's stern
4. Off the boat's bow

Recognize aspects of shiphandling and describe forces acting upon a ship under way.

3-29. One advantage of a twin-screw ship over a single-screw ship is that a twin-screw ship can maneuver in closer quarters.

3-30. Which of the following statements best explains the fact that a ship moves aft when the direction of the screw is reversed?

1. The water is pushed forward
2. The propeller thrust is canceled
3. The pressure areas are reversed
4. The dynamic pressure is canceled

3-31. When is the effect of side force on a ship most important?

1. When steaming at maximum speed
2. When steaming at cruising speed
3. When going alongside a ship underway
4. When going alongside a pier

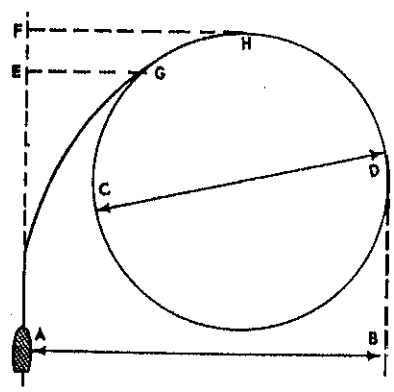

Figure 3B.--Ship turning circle.

● Questions 3-32 through 3-34 are based on the ship turning circle shown in figure 3B. Assume the rudder is put over at point A.

3-32. The advance is represented by line

1. AB
2. AF
3. CD
4. FH

3-33. Tactical diameter is the distance

1. AB
2. AG
3. CD
4. GB

3-34. Distance CD may be decreased by

1. increasing speed
2. increasing rudder angle
3. decreasing rudder angle and increasing speed
4. decreasing both rudder angle and speed

● Information for questions 3-35 through 3-41: Assume you are in command of a single-screw, single-rudder craft. You will encounter many different shiphandling situations. To answer the following questions assume that ideal conditions exist except where winds and current are specifically mentioned.

3-35. When moving ahead, where is the pivot point of a ship located?

1. About one-third the ship's length abaft the bow
2. Half the distance from bow to stern
3. Near the bow
4. Near the stern

3-36. When going ahead from a stopped position with the rudder hard right, what is the first reaction of a single-screw ship?

1. The stern swings to port
2. The stern swings to starboard
3. The ship moves straight ahead

3-37. To back out of a berth in a straight line, you have to alternate screw direction and rudder position. This action is necessary because, when backing, side force is

1. weak but discharge current against the rudder is strong
2. strong but discharge current against the rudder is weak
3. weak but suction current against the rudder is strong
4. strong but suction current against the rudder is weak

3-38. You find it necessary to change the heading of your ship 180° in an anchorage where you don't have much room to maneuver. Which of the following forces do you want to avoid using while casting?

1. Side force
2. Discharge current
3. Propeller thrust
4. Suction current

3-39. You are moored starboard-side-to 10 yards ahead of another vessel. With a following current, what is the best way to get away from the pier?

1. Take in all lines and back down with rudder hard left
2. Take in all lines except #1 and back down with rudder hard left
3. Spring on #2 line while kicking ahead slow with rudder left full
4. Spring on #2 line while kicking ahead slow with rudder right full

3-40. When proceeding along a channel close to a bank, the bow of a ship tends to move in what direction?

1. Away from the near bank, and the stern also moves away from the bank
2. Away from the near bank, while the stern is pulled toward the bank
3. Toward the near bank and the stern also moves toward the bank
4. Toward the near bank, while the stern is pushed away from the bank

3-41. A ship with a standard speed of 15 knots is moving ahead at that speed. Which of the following commands should the OOD first give the operator of the engine order telegraph if he wants to reduce the speed of the ship from 15 knots to 10 knots?

1. "Reduce speed 5 knots"
2. "Reduce speed one-third"
3. "Two-thirds speed ahead"
4. "All engines ahead two-thirds"

Learning Objective: Recognize the duties and responsibilities of the OOD underway and in port.

3-42. Which of the following information must be recorded in the deck log?

1. Courses and speeds of the ship
2. Particulars of anchoring and mooring
3. Draft
4. All the above

3-43. The deck log is prepared in the manner and form prescribed by the commanding officer.

3-44. Assume that you are scheduled to relieve the OOD underway. When you arrive on the bridge, you find that the ship is on a dangerous course. Which of the following actions should be taken before you relieve?

1. The OOD reports the situation to the captain and receives permission to be relieved
2. The OOD signs a written report of the situation when relieved
3. You report the situation to the captain and receive appropriate orders
4. You sign an entry in the log describing the situation at the time of relieving

3-45. Which of the following signal flags is displayed to indicate that a ship is preparing to get under way?

1. BRAVO
2. ECHO
3. UNIFORM
4. YANKEE

3-46. If the navigator recommends a change of course to avoid dangerous shoals, what action should the OOD take?

1. Secure permission from the captain to change course
2. Change course as recommended and report it to the captain
3. Study the chart and the DRT before changing course
4. Request the navigator to confer with the captain on what action to take

3-47. When the ship is under way, which of the following reports does the OOD submit to the commanding officer at 0800 daily?

1. Winding of the chronometers
2. Ship's position
3. Amount of fuel and water on board
4. All the above

3-48. The OOD of a Navy ship must return the salute of a merchant ship that dips its ensign unless the

1. merchant ship is flying a foreign flag not recognized by the U.S. Government
2. merchant ship is flying the U.S. flag
3. Navy ship is at anchor
4. merchant ship is flying a foreign flag

3-49. When a flag officer making an official call is embarked in a boat, the boat will fly the ensign aft and the

1. flag officer's personal pennant aft
2. flag officer's miniature pennant aft
3. jack forward
4. flag officer's personal pennant forward

● Information for questions 3-50 through 3-52: A boat approaching a ship at night is hailed from the quarterdeck with "Boat Ahoy." The response of the coxswain indicates the rank of the senior person in the boat. From column B, select the correct response for the person(s) listed in column A.

	A. Person(s)	B. Responses
3-50.	A chief of staff	1. "Hello"
3-51.	Vice Chief of Naval Operations	2. "Naval Operations"
		3. "Passing"
3-52.	Enlisted personnel	4. "Staff"

3-53. Which of the following is the correct daylight response for a coxswain carrying a rear admiral in his or her boat?

1. "Rear Admiral"
2. "Admiral"
3. Coxswain holes up four fingers
4. Coxswain holds up six fingers

Learning Objective: Identify various methods of determining a ship's position.

● Questions 3-54 through 3-57 describe means of determining a ship's position. For each question, name the method of navigation described using the following alternatives.

1. Electronic navigation
2. Dead reckoning
3. Piloting
4. Celestial navigation

3-54. Referring the ship's location to that of bodies in the sky such as the Sun, Moon, planets, or stars

3-55. Using bearings and distances from objects you can see on the Earth's surface such as lighthouses, steeples, and points of land

3-56. Using bearings and distances obtained with equipment such as radio-direction finders, loran, and radar

3-57. Estimating the direction and distance traveled from a known point of departure

3-58. For purposes of navigation, the shape of the Earth is considered to be a sphere.

3-59. Imaginary lines running around the Earth and through the poles are called

1. meridians
2. isobars
3. parallels
4. isopleths

3-60. What divides the Earth into the Northern and Southern Hemispheres?

1. Earth's axis
2. Greenwich meridian
3. Equator
4. International date line

3-61. A nautical mile is approximately equal to which of the following distances?

1. 5280 feet or 1584 meters
2. 5820 feet or 1746 meters
3. 6000 feet or 1800 meters
4. 6076 feet or 1852 meters

3-62. What is the starting point used for numbering meridians?

1. The Equator
2. The North Pole
3. Greenwich, England
4. The South Pole

3-63. The Earth is divided into the Eastern and Western Hemispheres by which of the following imaginary lines?

1. Equator
2. Greenwich and 180th meridians
3. 0° Parallel
4. 90° east and 90° west meridians

3-64. Parallels are numbered from 0° to 360°.

3-65. Which of the following statements concerning latitude and longitude is/are correct?

1. Latitude never is greater than 90°
2. Longitude is always from 0° to 180°
3. Latitude 90°N is the North Pole
4. All of the above

3-66. A ship that is at 0° latitude and 175°W longitude is at what location?

1. Equator
2. Greenwich meridian
3. North Pole
4. International date line

Learning Objective: Define a great circle and explain its significance to navigation.

3-67. What is a circle whose plane passes through the center of the Earth?

1. Center plane
2. Bisecting plane
3. Great circle
4. Small circle

3-68. Which of the following lines are great circles?

1. All meridians of parallels
2. All meridians and the Equator
3. All parallels except the Equator
4. All parallels and the Greenwich meridian

3-69. What is the shortest distance between two points on the Earth's surface?

1. A straight line tangent to the Equator
2. A curved line as part of a great circle
3. Along the great circle passing through both points
4. A rhumb line parallel to any meridian

3-70. A minute of longitude is equal to one nautical mile when longitude is measured along which of the following lines?

1. The Equator
2. Any parallel
3. Any parallel except the Equator
4. A small circle

Assignment 4

Navigation for the Boatswain's Mate (continued); Amphibious Duties; Painting; Damage Control Organization

Textbook, NAVEDTRA 10122-E: Pages 9-3 through 12-6

Learning Objective: Describe various methods of measurement used in navigation.

4-1. Which of the following phrases correctly defines the term "knots"?

1. Nautical miles
2. Statute miles
3. Nautical miles per hour
4. Statute miles per hour

4-2. How many degrees are there between each of the old style compass points?

1. 5-1/2°
2. 11-1/4°
3. 32°
4. 360°

4-3. How many figures are used to express courses and bearings?

1. One
2. Two
3. Three
4. Four

4-4. When taking a bearing, you would normally read it no closer than

1. 1/20th of a degree
2. 1/4th of a degree
3. 1/2 of a degree
4. 1 degree

4-5. True direction in the Navy is expressed in

1. degrees, measured clockwise from true north
2. degrees, measured counterclockwise from true north
3. points, measured clockwise from true north
4. points, measured counterclockwise from true north

4-6. What type of bearing indicates the angle between the line of sight to an object and the ship's head?

1. True
2. Magnetic
3. Relative
4. Geographic

4-7. What is the reciprocal of 330°?

1. 120°
2. 130°
3. 140°
4. 150°

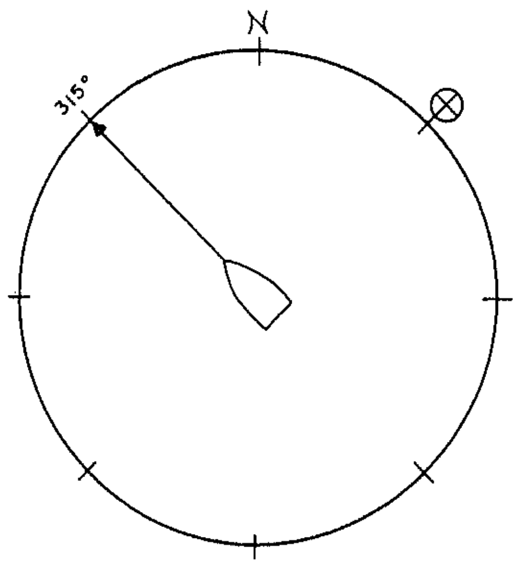

Figure 4A

- Refer to figure 4A for questions 4-8 and 4-9. Your ship is on a heading of 315° true and point X is 090° relative from you.

4-8. What is the true bearing of X ?

1. 045°
2. 090°
3. 270°
4. 315°

4-9. How might a lookout report the location of X ?

1. "On the starboard bow"
2. "On the starboard beam"
3. "On the port beam"
4. "On the port bow"

Learning Objective: Describe piloting methods and equipment used to determine and plot a ship's position.

4-10. Which of the following statements best describe(s) a dead-reckoning (DR) position?

1. It is the exact position of ship
2. It is accurate to one-half mile
3. It is an extimated position
4. All of the above

4-11. What are the minimum plotting requirements of a fix?

1. A line of position
2. Three lines of position
3. Two parallel lines of position
4. Two intersecting lines of position

4-12. Which of the following types of underwater logs is used on Navy ships?

1. Pitostatic
2. Electromechanical
3. Electromagnetic
4. Each of the above

4-13. The most accurate underwater log is the electromechanical.

4-14. What speed is measured by a log?

1. Actual speed over the ground
2. Speed through the water
3. Speed of drift in knots
4. Speed in miles per hour

4-15. Which of the following is a method of determining position and directing the movement of a vessel by reference to landmarks, navigational aids, or soundings?

1. Dead-reckoning
2. Piloting
3. Running fixes

4-16. Lines of position consists of which of the following factors?

1. Range
2. Bearings
3. Distance arcs
4. All the above

4-17. Which of the following instruments is a nonmagnetic metal ring equipped with sighting devices and fits over a gyro repeater or a magnetic compass?

1. Synchronous alidade
2. Telescopic alidade
3. Bearing circle
4. Stadimeter

4-18. Which of the following statements best describes what is meant when a ship is said to be "on the range"?

1. Two landmarks are observed in line
2. The ship is at the intersection of two distance arcs
3. Radar ranges are being used
4. The ship is running a calibration range

4-19. How do you convert a relative bearing of a landmark to a true bearing?

1. Subtract the ship's true heading
2. Add the gyro error
3. Subtract the gyro error
4. Add the ship's true heading

4-20. When an observer takes a bearing on a terrestrial object, from which point and in what direction does he/she plot the bearing line of position?

1. From the ship in a reciprocal direction
2. From the ship in the direction of the landmark
3. From the landmark in a reciprocal direction
4. From the landmark in the direction of the bearing

4-21. What is a circular line of position whose radius is the distance from a landmark to the observer?

1. A tangent bearing
2. A distance arc
3. A tangent arc
4. A range

4-22. Which of the following instruments is used to measure distance from your ship to others in a formation?

1. Alidade
2. Sextant
3. Stadimeter
4. Synchronous alidade

4-23. Which of the following plotting symbols indicates a dead-reckoned position ?

1. 
2. 
3. 
4. 

4-24. What do you do when three lines of position intersect to form a small triangle?

1. Take new bearings
2. Mark the fix at the intersection of the last two lines of position
3. Mark the fix at the intersection of the first two lines of position
4. Mark the fix at the center of the triangle

4-25. Which of the following methods of fixing a ship's position is the most accurate?

1. Taking a range and bearing to a single object
2. Establishing intersecting lines of position with bearings of two or more objects
3. Taking horizontal sextant angles between three fixed objects
4. Taking successive bearings of a single fixed object

4-26. What instrument is used to plot a position obtained by horizontal sextant angles?

1. Dead-reckoning tracer
2. Dividers
3. Parallel rulers
4. Three-arm protractors

4-27. The intersection of a line of position obtained from a bearing with an advanced line of position is called a(n)

1. estimated position
2. approximate fix
3. estimated fix
4. running fix

4-28. Locating the position of a ship by means of bow and beam bearings results in what type of fix?

1. A running fix
2. A simultaneous fix
3. A DR position
4. An estimated position

Learning Objective: Describe relative motion and solve maneuvering board problems.

4-29. If two ships travel due east at different speeds along the same parallel of latitude, the relative speed will be equal to the

1. square root of the product of their actual speeds
2. average of their actual speeds
3. difference between their actual speeds
4. sum of their actual speeds

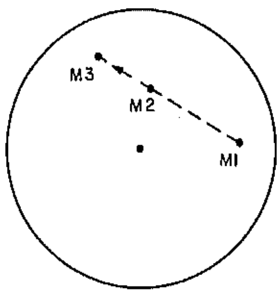

Figure 4B

4-30. Assume you are on the bridge of a CV and figure 4B represents the PPI scope of your ship's radar. If M1, M2, and M3 represent radar pips of a DD changing station, the line formed by M1, M2, and M3 represents the

1. relative motion of the CV with respect to the DD
2. relative motion of the DD with respect to the CV
3. actual motion of the CV
4. actual motion of the DD

4-31. Which of the following elements is found in both the relative plot and the vector diagram?

1. Distance of relative movement
2. Relative speed
3. Maneuvering ship's course
4. Direction of relative movement

4-32. The length of the line M1-M2 in the relative plot represents

1. relative distance
2. true distance
3. relative speed
4. true speed

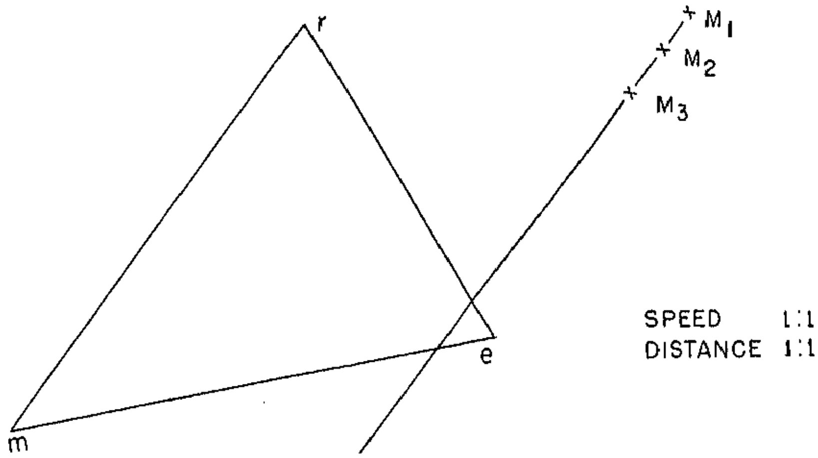

Figure 4C.--Using the relative plot and vector diagram.

4-33. Figure 4C shows a plot made aboard your ship of another ship tracked by radar. Assume the distance from M_1 to M_3 in figure 4C to be 1600 yards. If the contact traveled that distance in 6 minutes, what is its relative speed?

1. 6 knots
2. 8 knots
3. 12 knots
4. 16 knots

4-34. When the contact in figure 4C is at CPA, the bearing from you will be approximately

1. 060°
2. 350°
3. 128°
4. 308°

4-35. In figure 4C, own ship's course and speed are indicated by the direction and length of line

1. *em*
2. *er*
3. *rm*
4. M_1M_3

● Information for items 4-36 and 4-37. The OOD wishes to change course to the right so that the contact in figure 4C will have a minimum range of 2,000 yards at CPA. Own speed will remain the same. The contact does not change course or speed.

In determining the new course to come to, you start by laying out the new relative movement line from M_3 to the required CPA.

4-36. You then draw a line parallel to the new relative movement line from the end of the vector labeled

1. *em*
2. *er*
3. *rm*
4. *e*M3

4-37. Proceed along the line drawn in item 4-36 to the point where it intersects the circle representing own ship's true speed. The course to steer is then determined by the bearing of this point from

1. M_1
2. *e*
3. *r*
4. *m*

Learning Objective: Describe methods of pontoon assembly and launching. Identify equipment used in pontoon assembly and launching.

4-38. A 4x12 pontoon assembly consists of

1. pontoons whose dimensions are 4 feet by 12 feet
2. 4 pontoons, each 12 feet square
3. 4 strings, each 12 feet long
4. 4 strings of 12 pontoons each

4-39. The 6A bolts used to secure assembly angles to pontoon units are prevented from coming loose by

1. keeper plates
2. flanged nuts welded to the units
3. link pins
4. cotter pins

4-40. If launching rollers are not available for aid in assembling a string, approximately how far apart are assembly angles spaced?

1. 6 feet 1 inch
2. 5 feet 9 inches
3. 5 feet 2 inches
4. 4 feet 7 inches

4-41. The final operation in securing pontoon strings together is the attachment of

1. A10 bolts
2. assembly plates
3. tie rods
4. angle clamps

4-42. Inshore and offshore causeway sections always are loaded with the ramp forward.

4-43. Which of the following is the preferred method for launching causeways?

1. Freefall
2. Semicontrolled
3. Controlled

4-44. In the three-point LST-causeway marriage, which of the following anchors holds the LST away from the causeway?

1. Port
2. Starboard
3. Bower
4. Stern

Learning Objective: Describe the responsibilities of a paint locker supervisor. Identify safety equipment and identify safety procedures used in painting.

4-45. Which of the following is the purpose of painting?

1. Protection
2. Identification
3. Habitability
4. Each of the above

4-46. The flammable liquid storeroom is always located below the waterline.

4-47. Thinner splashing on a small bulkhead in the paint shop has destroyed the paint film in several places and caused spot corrosion. What action should be taken to repair the damage?

1. Touchup painting of the corroded spots, because more extensive painting would be wasteful
2. Touchup painting of the corroded spots, because any extra paint should be reserved for use in living spaces
3. Complete repainting of the bulkhead because plenty of paint is available
4. Complete repainting of the bulkhead, because there is more than one corroded spot

4-48. The amount and types of equipment available for the paint locker are designated by the COSAL.

4-49. Before they are used, new paint-brushes should be rinsed with which of the following liquids?

1. Water
2. Thinner
3. JP-5
4. Linseed oil

4-50. How should brushes that are not to be reused immediately be stored?

1. Suspended from racks
2. Flat, wrapped in paper
3. Both 1 and 2 above
4. Soaked in water

4-51. Assume you are teaching a new man how to clean a respirator that has just been used in spray painting. What are the proper cleaning fluids to use?

1. Thinner, soap and water solution, disinfectant, and paint remover
2. Thinner and disinfectant solution only
3. Thinner, disinfectant solution, and paint remover
4. Thinner, soap and water solution, clear water and disinfectant solution

4-52. Some kinds of material in the paint shop should be kept in tightly sealed containers. To avoid the danger of explosions, a gas-release pinhole should be located in the lid of every can containing

1. paint
2. paint thinner
3. alcohol
4. dust-zinc oxide

4-53. Which of the following materials in NOT a health hazard in a paint locker?

1. Clean clothing
2. Corrosive agents
3. Dust
4. Mists

4-54. Which of the following materials may safely be used to remove paint from skin?

1. Thinner
2. Petrolatum
3. JP-5
4. Gasoline

4-55. Which of the following equipment must be worn when working near or over water?

1. Life jacket
2. Tending line
3. Safety harness
4. All of the above

In items 4-56 through 4-58, select from column B the description that best fits the respirator listed in column A.

	A. Respirators	B. Descriptions
4-56.	Dispersoid respirator	1. To be used where ventilation cannot be supplied
4-57.	Chemical cartridge respirator	2. Protects against dust
4-58.	Supplied air respirator	3. Protects against fumes and vapors
		4. Protects against smoke

Learning Objective: Recognize the objectives of shipboard damage control. Describe the damage control organization aboard ship. Recognize duties of personnel in a repair party.

4-59. Which of the following phases of damage control is the most important?

1. Before damage occurs
2. During combat
3. After combat

4-60. Which of the following personnel is responsible for assigning repair party personnel to form an effective damage control and damage repair group?

1. Executive officer
2. Damage control assistant
3. Repair party leader
4. Scene leader

4-61. The scene leader is the assistant repair party leader.

4-62. Which of the following personnel ensures that all safety precautions and standard procedures are observed during evolutions?

1. Repair party leader
2. Scene leader
3. Safety observer
4. Repair party electrician

For items 4-63 through 4-66, select from column B the duties performed by the repair party personnel listed in column A.

	A. Repair Party Personnel	B. Duties
4-63.	Repair party electrician	1. Nozzleman, #1 hose team in case of fire
4-64.	#2 OBA man	2. Nozzleman, #2 hose team in case of fire
4-65.	Messenger	3. Rigs casualty power
4-66.	#1 OBA man	4. Accompanies #1 OBA man on preliminary investigation

---

Learning Objective: Describe the organization of a firefighting party and recognize duties of personnel in a firefighting party.

4-67. When using the nucleus fire party to fight a fire, which of the following repair lockers is manned to back up and assist the nucleus fire party?

1. Repair locker FIVE only
2. Repair locker TWO only
3. Repair locker THREE only
4. The repair locker in the vicinity of the fire

4-68. When a fire occurs in port and only a partial crew is aboard, which of the following repair parties will respond?

1. Duty repair party
2. Repair locker TWO
3. Repair locker THREE
4. Repair locker FIVE

4-69. At least how many personnel are required to man a 1 1/2-inch firehose?

1. One
2. Two
3. Three
4. Four or more

4-70. Which of the following personnel set(s) the fire boundaries established by DC central?

1. Plugman
2. Investigators
3. Access men
4. Messenger

4-71. There is a possibility that fire may spread by which of the following methods?

1. Conduction
2. Radiation
3. Convection
4. All the above

4-72. Only 2 1/2-inch hoses should be used for below-deck fires.

COURSE DISENROLLMENT

All study materials must be returned. On disenrolling, fill out only the upper part of this page and attach it to the inside front cover of the textbook for this course. Mail your study materials to the Naval Education and Training Program Development Center.

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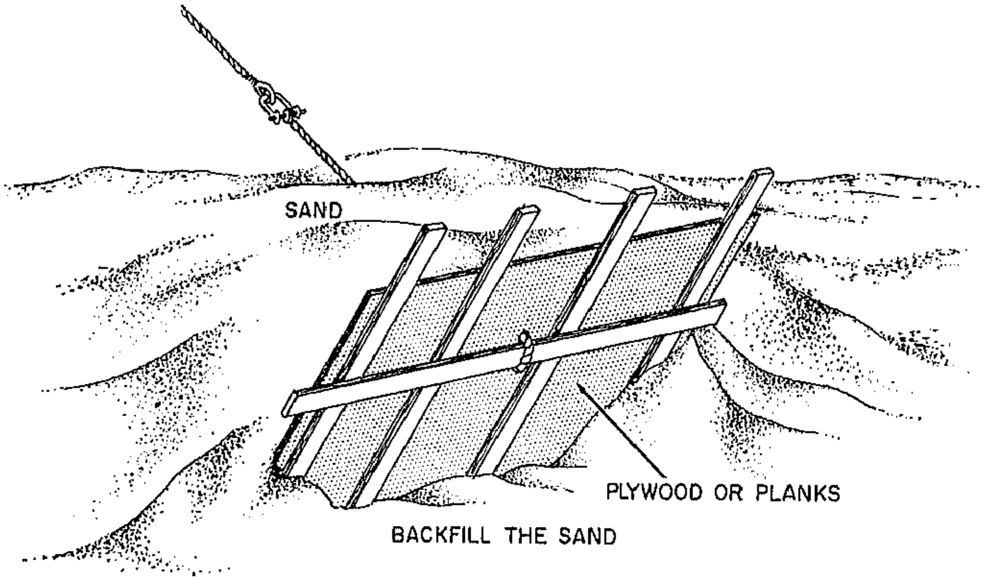

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Figure 2-25.—One type of anchorage to use in sand.

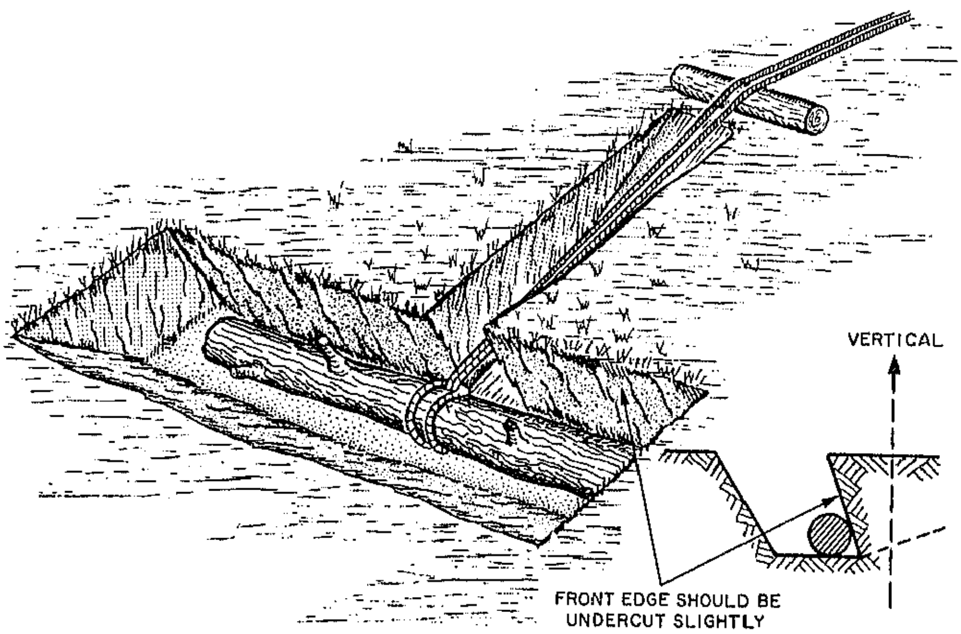

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Figure 2-26.—Log-in-ditch anchorage.